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CONTRIBUTIONS TO A SOUTH INDIAN MARINE ALGAL FLORA. I.

BY

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Communicated by M. O. P. Iyengar

The following account of the marine algæ of South India is based mainly on collections made some years ago by Professor M. O. PARTHASARATHY IYENGAR of Madras, who most kindly placed at my disposal all his collections of seaweeds with the exception of the Chlorophyceæ which he proposes to work out himself.

The collection consisted of a small number of dried specimens, consisting, as a rule, of only a single or sometimes a few specimens of each species. and a very large number of specimens preserved in 6% sea-water formalin. Since the material was kept in this solution for many years, sometimes even about as long as 20 years, the algæ were not always in their best condition.

In the beginning of 1928, I also made a small collection of algæ at Karvar in Bombay Presidency and at Tuticorin in South India during a short visit. Some species from these localities also are included in this account.

Of the larger algæ in the material examined by me, I did not find many forms of special interest; these have already been

collected by HARVEY, FERGUSSON and others or have already been described in MME. WEBER's great work on the Siboga Algæ from the Malayan Archipelago. On the other hand, I came across many small epiphytes and endophytes which were often very interesting.

As in the following pages I shall often quote the papers of Indian algæ already published by myself, I give a list of them here with indications as to how they are cited. The papers are:—

Some Indian Rhodophyceae especially from the shores of the Presidency of Bombay, I-IV. in Kew Bulletin 1931, 1932, 1933, 1934; these papers will be quoted as "Kew Bull." 1931, 1932 and so on.

Some Indian green and brown algae especially from the shores of the Presidency of Bombay, I-III, in the Journal of the Indian Botanical Society, vol. IX, 1930, vol. XI, 1932 and vol. XII, 1933. These papers will be referred to as "Journ. Ind. Bot. Soc.", vol. IX, vol. XI and vol. XII.

Some marine algae from the Northern part of the Arabian Sea with Remarks on their geographical Distribution in Kgl. Danske Videnskabernes Selskab. Biologiske Meddelelser, XI, 6, Koebenhavn, 1934. This paper will be quoted as "Some mar. Alg. Arabian Sea."

A list of marine Algae from Bombay. ibid. XII, 2, Koebenhavn, 1935. This paper will, be quoted as "List mar. Alg. Bombay."

When Professor IYENGAR is the collector of a plant, I have in most cases used the abbreviation, M. O. P. I. When I myself have gathered the plant I have put ! after the name of the locality.

CHLOROPHYCEÆ

I. Ulotrichales.

Fam. I. ***Chætophoraceae.***

Phaeophila Hauck.

1. **Phaeophila dendroides** (Cr.) Batters, Cat. Brit. Alg. 1902, page 13. HAMEL, Chlorophycées des côtes françaises, 1930, page 27. *Ochlochæte dendroides* Crouan, Flor. Finist., page 128.

This species was found abundantly on old leaves of *Enhalus acoroides* gathered in October 1921 by M. O. P. IYENGAR. The creeping filaments were from 12-33μ thick.

I n d i a: Pamban, leg. M.O.P.I.

D i s t r.: Mediterranean Sea, Atlantic coast of Europe, Canary Islands, West Indies, etc.

II. Siphonocladiales.

Fam. 1. ***Valoniaceæ.***

Valonia Ginn.

1. Valonia Forbesii Harv. Alg. Ceylon. No. 75, (nomen nudum). J. AGARDH, Till Algernes Systematik, VIII, page 96. F. Boergesen, Some marine algae from Ceylon. Ceylon Journ. Sci. (A) Vol. XII, Pt. 2, 1936, p. 62, fig. 1.

I collected some very fine specimens of this species at Tuticorin. The specimens are mentioned and figured in a paper on some marine Algæ from Ceylon which will shortly be published in the Ceylon Journal of Science, Botany.

India: Tuticorin.

Distr.: South India, Malayan Archipelago, Tahity Friendly Islands, etc.

III. Siphonales.

Fam. 1. ***Codiaceæ.***

Codium Stackh.

1. Codium coronatum Setch., Tahitian Algæ in Univ. of Cal. Publ. in Bot., Vol. 12, 1926, p. 82, pl. 10, figs. 2-5; pl. 11, figs. 2, 3; pl. 12, figs 1, 5.

This characteristic species is easily recognised by its irregularly shaped, coxcomb-like thallus. It was originally described from Tahity and seems to be fairly well distributed in the Indian-Pacific Ocean.

India: Tuticorin: Hare Island.

Distr.: Tahity, Ceylon, India.

PHAEOPHYCEÆ

I. Ectocarpales.

Fam. 1. ***Ectocarpaceæ***

Ectocarpus Lyngb.

1. Ectocarpus Duchassaingianus Grun. Algæ, in Reise der Osterreichischen Fregatte Novara um die Erde, Bot. Theil, 1. Bd., 1870, p. 45, tab. IV, fig. 1. BOERGESEN, Mar. Alg. D.W.I., vol. I, pp. 159-162, figs. 127-8. SETCHELL, W. A., American Samoa (Department of Marine Biology of the Carnegie Institution of Washington, vol. XX, 1924, p. 170, fig. 35.)

The Indian specimens like those found by SETCHELL are much smaller than the West Indian ones forming low dense dark brown tufts about ½ cm. high on the old stems of other algæ; the small size of the Indian specimens is evidently due to its growing in an open, very much exposed surf-beaten locality. In size and shape, the plurilocular sporangia of the alga agree very well with those of the West Indian plant as well as with SETCHELL'S figure quoted above, the only difference from the West Indian plant being that the sporangia in the Indian plant are a little less clavate or not clavate at all, often being thickest near the middle and agreeing with most of the sporangia in SETCHELL'S figure. As pointed out by me, l. c., p. 160-1, and later by SETCHELL, p. 170, I think that the *Ectocarpus indicus* mentioned by MME. WEBER (Algues. .. Siboga, p. 130, fig. 34) is merely a form of *Ectocarpus Duchassaingianus.* I collected the plant during a visit to the Seven Pagodas in the month of February along with Prof. Iyengar.

India: Mahabalipuram (The Seven Pagodas)!

Distr.: West Indies, Tutuila Island, Malay Archipelago(?).

2. **Ectocarpus Mitchellae** Harv., Nereis Bor. Am. Part I, 1851, p. 142, pl. XXI, fig. G. BOERGESEN in Journ. of the Ind. Bot. Soc., vol. IX, 1930, p. 165, fig. 8 (here more literature and synonyms).

Intermingled among *Ectocarpus coniferus* in a collection of algæ from Pamban was found an *Ectocarpus* with cylindrical sporangia. The shape of the plurilocular sporangia in this plant agreed exactly with ASKENASY'S figure in "Flora", 1894, pl. 1, fig. 6. Further, this plant was also very much like SETCHELL'S figure in "American Samoa" (in Department of Marine Biology of the Carnegie Institution of Washington, vol. XX, 1924, pp. 169-170, fig. 34). SETCHELL considers his plant to be like *Ectocarpus indicus* Sonder, whereas ASKENASY presumes that *Ectocarpus indicus* has two forms, one the above mentioned form with cylindrical sporangia and another with conical sporangia (compare his figure l.c., pl. II, fig. 8*).

Referring the reader to my remarks in the paper quoted above, I feel inclined to consider the forms with cylindrical sporangia mentioned therein as belonging to HARVEY'S *Ectocarpus Mitchellae.* Until now I have examined numerous specimens most probably belonging to this plant and from widely spread localities that it seems impossible to separate them. Since *Ectocarpus Mitchellae* is an older name (1851) than SONDER'S *Ectocarpus indicus* (1854), we are saved the

* I think that the last mentioned form with conical sporangia is like the plant I have described as a new species, *Ectocarpus coniger* Boergs., in "A List of Marine Algæ from Bombay" (Biologiske Meddelelser, XII, 2, Koebenhavn 1935, pp. 31-34, figs. 14-16).

difficulty regarding SONDER'S species, the orginal specimen of which, as pointed out by SETCHELL, most probably consists of a mixture of several species.

India: Pàmban, Oct. 1922, leg. M. O. P. I.

Distr.: Seems to occur in most warmer seas.

3. Ectocarpus coniferus Boergs.,[1] Mar. Alg. D.W.I., vol. I, 1914, p. 164, figs. 131-2.

When I found this plant (fig. 1), in Prófessor IYENGAR'S collection, I was immediately struck by its great resemblance to the West Indian species, *Ectocarpus coniferus*, which is evident when one compares the accompanying figure with my figures quoted above. And, after a thorough comparison with the original material, I feel quite certain that the Indian plant cannot be separated from the West Indian one. The Indian specimens were found as epiphytes on old leaves of the sea-grass, *Enhalus acoroides*, to which the basal decumbent filaments were attached. The main filaments are about 40μ thick and are composed of cells of about the same length or up to 3-4 times the breadth; the branches become gradually thinner upwards. Near the base of the branches an intercalary zone of division is found from which the cells upwards become longer and thinner and gradually die away near the tip. In the zone of division the cells are crowded with chromatophores, which become more scattered upwards, the cells uppermost being almost colourless. The chromatophores have the shape of roundish discs. The plurilocular sporangia are placed in the way characteristic for this species, that is, singly or in short rows on the upper side of the branches near the base and especially in the corners. Two, three and sometimes more sporangia placed serially are found here. The plurilocular sporangia are oblong-conical with broadly rounded bases. They are always sessile and vary very much in size, being about 80-120μ long or more and about 30-40μ broad. I have not succeeded in finding any unilocular sporangia. It may be seen from this description that the Indian plant agrees in all respects with the West Indian one.

As I have already pointed out, its method of growth, shape of sporangia, etc., show some likeness to *Ectocarpus irregularis* Kütz., but nevertheless it differs from it, in many respects. This will be seen when one compares my figures with KUCKUCK'S figure published in OLTMANNS' Morphologie und Biologie der Algen, vol. II, 1922, p. 9, fig. 294. *Ectocarpus coniferus* may perhaps also remind one somewhat of *Ectocarpus coniger* Boergs. in "A List of Marine Algæ from Bombay" (Biologiske Meddelelser, XII, 2, Koebenhavn 1935, p. 31, figs. 14-16). But, besides other differences, the sporangia in this species are often pedicellate and their shape varies very much.

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(1) See postscript on p. 7.

Ectocarpus coniferus, however, seems to be much more like *Ectocarpus arabicus* Figari and De Notaris described in Nuovi Materiali per l'Algologia del Mar Rosso (Memorie della Reale Academia delle Scienze di Torino, Ser. II, t. XIII, 1853, p. 169, fig. V), a paper which I have not seen until recently. Even if FIGARI and DE NOTARIS' figure is rather schematical, it must

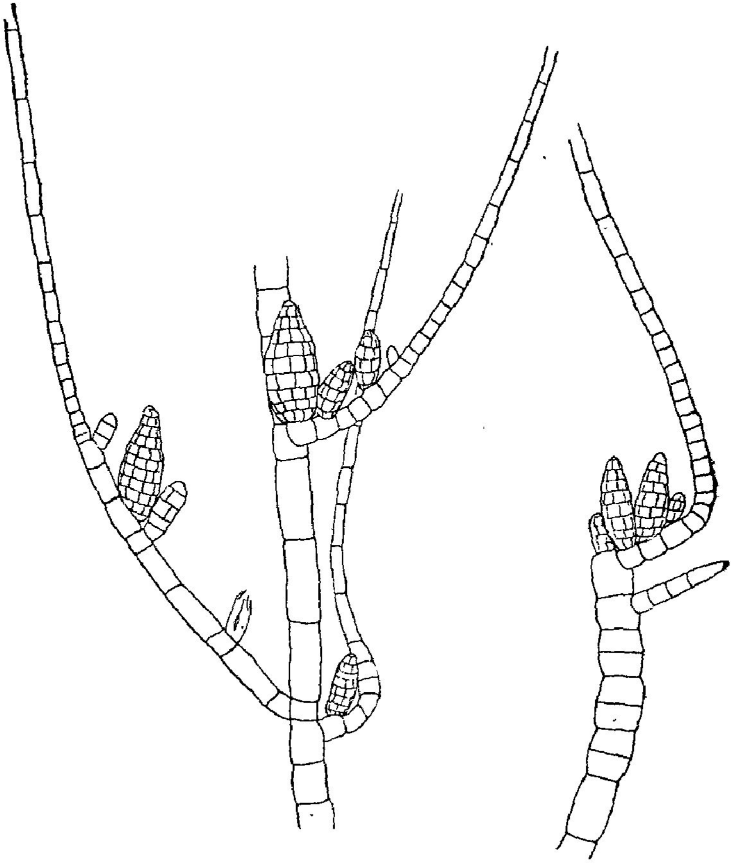


Fig. 1. *Ectocarpus coniferus* Boergs. Parts of filaments with plurilocular sporangia. × 250.

be admitted that the shape and position of the sporangia in the corners of the branches quite agree with those of my plant. Whether the sporangia, as is often the case with my species, also occur scattered along the upper side of the branches in the plant from the Red Sea neither FIGARI and DE NOTARIS' figure nor their description give any information about. To decide this point an examination of the original material is necessary and, until this is done, I think it is right that my species should be maintained. In this connection I wish to mention further that KÜTZING two years later in *Tabulæ Phycologicæ, vol. V, tab. 72*, has described an *Ectocarpus arabicus* nov. spec. which in the shape of its sporangia shows some likeness to this species, but in other respects is very different, for instance in the way in which the sporangia are placed, these being often pedicellate. And further it is quite a small plant forming tufts scarcely ½ cm. high. DE TONI (in Sylloge Alg., vol. III, Phæophyceæ, p. 546) refers KÜTZING'S plant to FIGARI and DE NOTARIS' species and, if DE TONI is right in doing so, my plant of course cannot be referred to FIGARI and DE NOTARIS' species.

The plant was gathered by IYENGAR in October 1921 as an epiphyte on *Enhalus acoroides*.

India: Pamban, leg. M. O. P. I.

Distr.: West Indies.

Postscript.—Long before I had thought it would be possible, I was able to examine some well preserved material of *Ectocarpus arabicus* Fig. et De Not. from the Red Sea. A young Egyptian algologist, Mr. A. H. NASR, from theUniversity of Cairo, has come to Copenhagen for some time in order to study a collection of marine algae gathered by him near the Egyptian Biological Station at Ghardaqa on the Red Sea. While looking through his collection of *Ectocarpus*, I came across some very good material of a plant which looked very much like FIGARI'S and DE NOTARIS' species, *Ectocarpus arabicus*. In this Red Sea material I find that the sporangia are placed not only in the corners of the branches as shown in FIGARI'S and DE NOTARIS' figures but also scattered all along the upper side of the branches. On the whole this plant resembles the Indian as well as the West Indian plants of *Ectocarpus coniferus*. The only difference I find is the sporangia in the plant from the Red Sea are somewhat shorter and proportionately thicker than those the West Indian plant, but this may perhaps be due to the fact that the plant from the Red Sea seems to be rather young, and the sporangia are not yet fully developed. The largest sporangium found by me in the material from the Red Sea is 92μ long and 38μ broad, white most of them were about 75μ long and 34μ broad only. But, leaving this minor difference out of consideration, the plant from the Red Sea agrees so

well with the West Indian and the Indian plants that I do not hesitate in referring them all to the same species and calling them by FIGARI'S and DE NOTARIS' name, *Ectocarpus arabicus*, as the older one and with *Ectocarpus coniferus* as a synonym.

Like *Ectocarpus Mitchellae* and *Ectocarpus Duchassaingianus*, (both these species are also found in Mr. NASR'S collection), this species also seems to have a very extensive distribution in warm seas.

Botanical Museum, Copenhagen, Sept. 1936.

4. Ectocarpus Enhali nov. sp.

Thallus epiphyticus, minutus, pulvinaria parva ad 1 mm. alta formans, ex filamentis repentibus et filamentis erectis compositus. Filamenta repentia sinuosa, plus minus irregulariter ramosa, e cellulis ca. 15μ latis et 2-4 plo longis formata. Filamenta erecta simplicia, raro ramosa, divisione cellularum intercalari in parte inferiore filamentorum crescentia, e cellulis ca. 15μ latis et 1½-3 plo longioribus, superne attenuata e cellulis 5μ latis et 100μ longis et ultra composita.

Sporangia plurilocularia terminalia aut lateralia, sessilia, oblonga, ca. 40-60μ longa et 18-22μ lata.

India: Pamban, on old leaves of *Enhalus acoroides* leg. M. O. P. I.

On old leaves of *Enhalus acoroides* was found a small *Ectocarpus* (figs. 2, 3) with creeping basal filaments. The creeping filaments are branched now and then and irregularly bent; they are about 15μ thick and composed of cells about two to four times as long. From the creeping filaments, the erect ones arise. These are of variable length, the longer ones reaching a height of about 1 mm. or more. The filaments are composed of cylindrical cells about 11-15μ broad and are shortest near the base, about 1½-3 times as long as broad becoming gradually longer upwards, being in the upper ends often more than 100μ long and tapering gradually to about 5-8μ. At the cross-walls the filaments are a little constricted. The upper cells in the younger filaments have a broadly rounded apex; in older filaments the uppermost cells die gradually. No marked growing point is found, but the cells in the lower parts of the filaments are divided occasionally. The chromatophores seem to consist of irregularly elongated or rounded discs, but as they have been kept in formalin for a long time they are rather damaged. The erect filaments are generally unbranched; only now and then does a filament send out a single branch.

The plurilocular sporangia are placed either terminally on short erect filaments or laterally on the long filaments. As far as I have seen they are always sessile. They are oval-oblong

in shape with broadly rounded apices and bases about 40-70μ long and about 22-28μ broad.

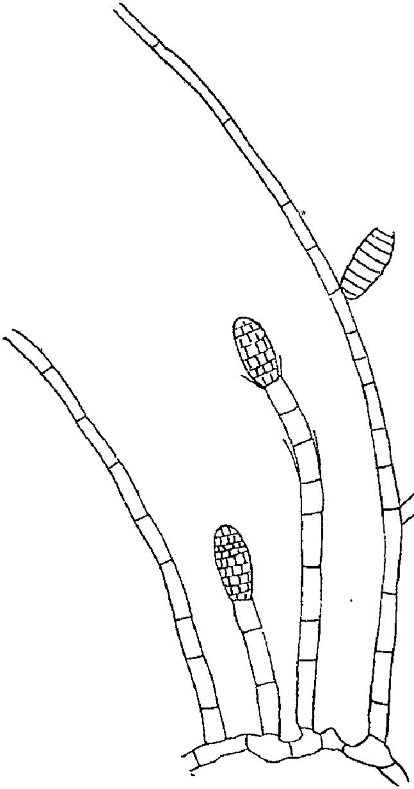


Fig. 2. *Ectocarpus Enhali* nov. sp. Part of the thallus with plurilocular sporangia. About × 300.

This species is probably related to *Ectocarpus Laurenciæ* Yamada (Notes on some Japanese Algæ II in Journ. Hokhaido Imp. University, Series V, vol. I, 1931, p. 66, fig. 1) but the Japanese plant differs in having apical growth. It may also remind one somewhat of *Ectocarpus columellaris* Boergs from Galle, Ceylon, (F. Boergesen, Some marine algae from Ceylon. Ceylon Journ. Sci. (A) Vol. XII, Pt. 2, 1936, p. 72, fig. 4). but this species is altogether smaller and the sporangia occa-

sionally pedicellate. It must also be compared with the plant, which I have referred in Mar. Alg. of the Danish West Indies, vol. II, p. 434, fig. 410, though with some doubt, to *Ectocarpus variabilis* Vickers, and which, like this plant, grows on old leaves of a sea-grass, but the West Indian plant is smaller and the sporangia are not only sessile but also pedicellate.

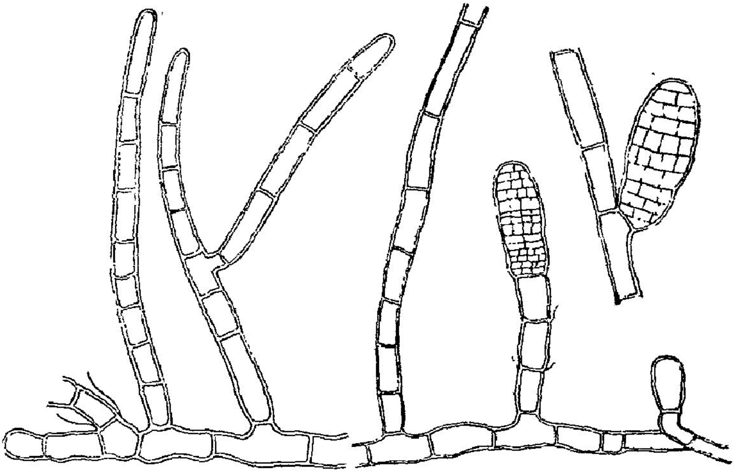


Fig. 3. *Ectocarpus Enhali* nov. sp. *Parts of plants with plurilocular* sporangia. × 500.

5. **Ectocarpus filifer** nov. sp.

Thallus in *Liagora erecta* subepiphyticus, cæspites parvos ad 1 mm. altos formans, e filamentis repentibus, parce ramosis, et filamentis erectis compositus. Filamenta repentia plus minus inter filamenta assimilatoricis hospitis immersa, irregulariter sinuosa e cellulis ca 7-10μ latis et 4-5 plo longioribus formata. Filamenta erecta, divisione intercalare in parte basale filamentorum crescentia, fere cylindrica ad septa transversaria leviter constricta e cellulis ca. 10-12μ latis et 2-4 plo longioribus constructa. Sporangia plurilocularia terminalia in pedicellis brevibus ex filamentis repentibus ortis, aut in parte basale filamentorum erectorum sessilia vel pedicellata, cylindrice-pyriformia, ca. 60-90μ longa et 22-27μ lata.

India: Mahabalipurum (The Seven Pagodas), leg. M. O. P. I.

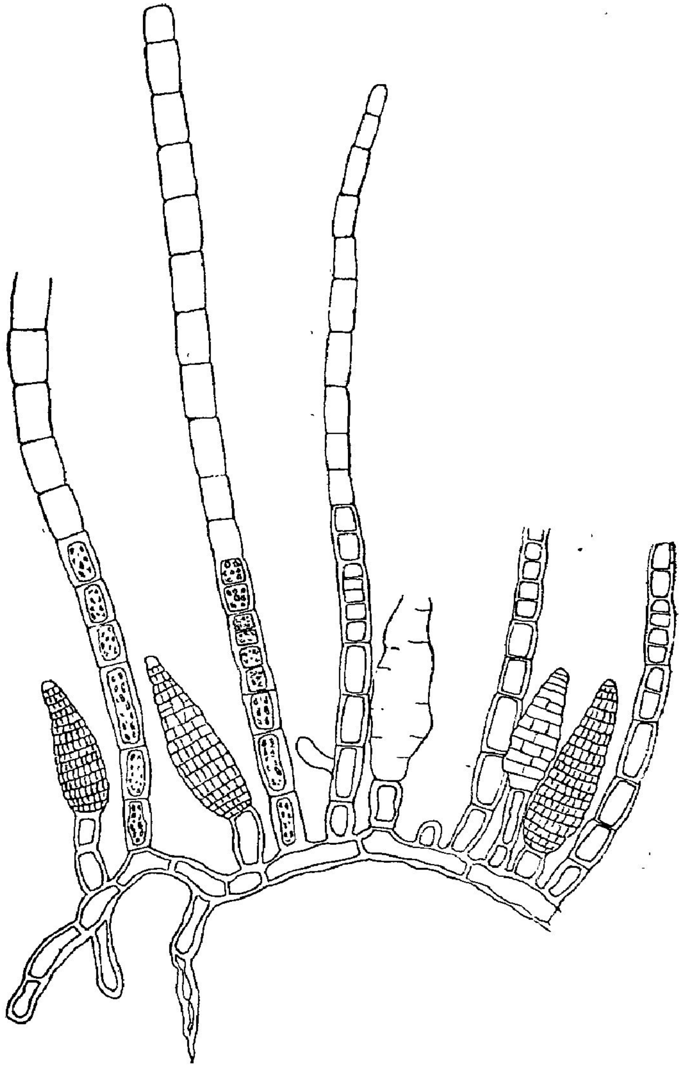


Fig. 4. *Ectocarpus filifer* nov. sp. Part of the thallus with plurilocular sporangia. About × 400.

This plant (figs. 4, 5) forms low felted cushions up to about 1 mm. high on *Liagora erecta*. The thallus consists of creeping filaments more or less immersed among the assimilating filaments of the host and from which erect filaments arise. The creeping filaments are irregularly ramified and sinuated, about 7-10μ thick and composed of shorter or longer cells from a little longer than broad up to about 4-5 times as long. From the upper sides of the creeping filaments are formed long assimilating shoots as well as short ones composed merely of a single or a few cells, the latter ending in plurilocular sporangia. The assimilating filaments have an intercalary short zone of division a little above the base. They have rather thick walls and are a little constricted at the cross walls. They are composed of cells about 10-12μ broad and 2-4 times as long and tapering more or less upwards. The apical cells are broadly rounded at the top. The cells contain several small irregularly shaped or roundish disc-shaped chromatophores. As far as I have been able to see, the erect filaments are not branched. The plurilocular sporangia are placed terminally on the short one- or two-celled filaments given out from the creeping filaments. They are elongated-pyriform to conical in shape and about 60-90μ long and 22-27μ broad. Moreover, sporangia are found now and then on the branches issuing from the lower part of these. These sporangia have almost the same shape but are generally smaller. They are pedicellate or sessile.

This species may remind one somewhat of *Ectocarpus Enhali* Boergs. described in this paper, of *Ectocarpus columellaris* Boergs. (from Galle, Ceylon) and of *Ectocarpus Laurenciæ* Yamada, but it differs from these in several respects.

6. **Ectocarpus thyrsoideus** nov. sp.

Thallus cæspites parvos ad 3-4 mm. altos formans, ex filamentis endophyticis valde ramosis et irregulariter sinuosis inter filamentis hospitis *(Liagora erecta)* circumvagantibus et ex filamentis erectis liberis sporangiferis compositus. Filamenta endophytica ex cellulis ca. 22μ latis et 2-5 plo longioribus formata. Filamenta erecta, sparse ramosa, divisione intercalari crescentia, ex cellulis plus minus doliiformibus ad septa transversaria constrictis ca 18-25μ latis et 1-6 plo et ultra longioribus constructis, Chromatophora irregulariter bacilliformia aut rotundata. Sporangia plurilocularia oblique cylindrico-conica, sessilia aut pedicellata, ca. 140μ longa et 25-35μ lata in filamentis erectis adsunt.

India: Mahabalipuram, Jan. 1922, leg. M. O. P. I.

This plant (figs. 6, 7) forms dense felted tufts about 3-4 mm. high. It consists of a basal part of very much and irregularly ramified filaments and an upper part of long and more or less ramified filaments bearing the plurilocular

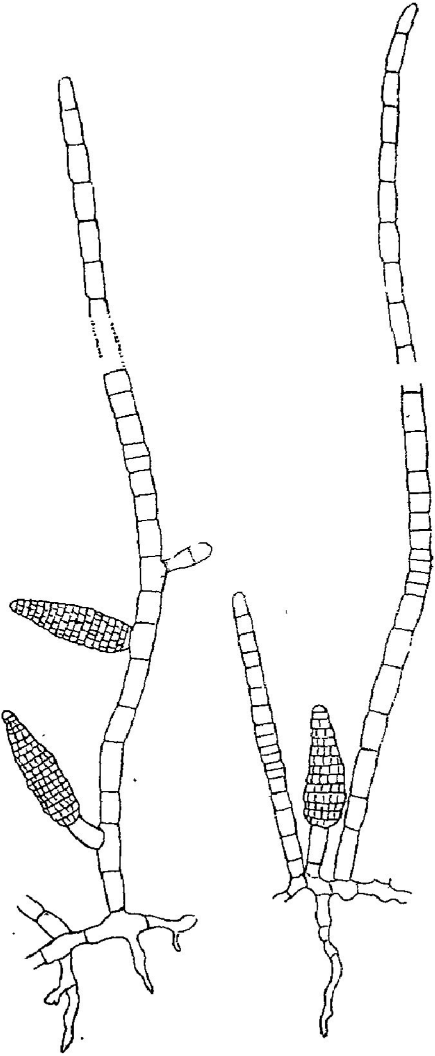


Fig. 5. *Ectocarpus filifer* nov. sp. Parts of the thallus with unilocular sporangia. × 250.

sporangia. The decumbent filaments are composed of very irregularly shaped cells, about 22μ broad and 2-5 times as long and are very much ramified, sending out branches in all directions between the filaments of the host. Some of the branches become rhizoid-like and grow more or less inwards into the tissue

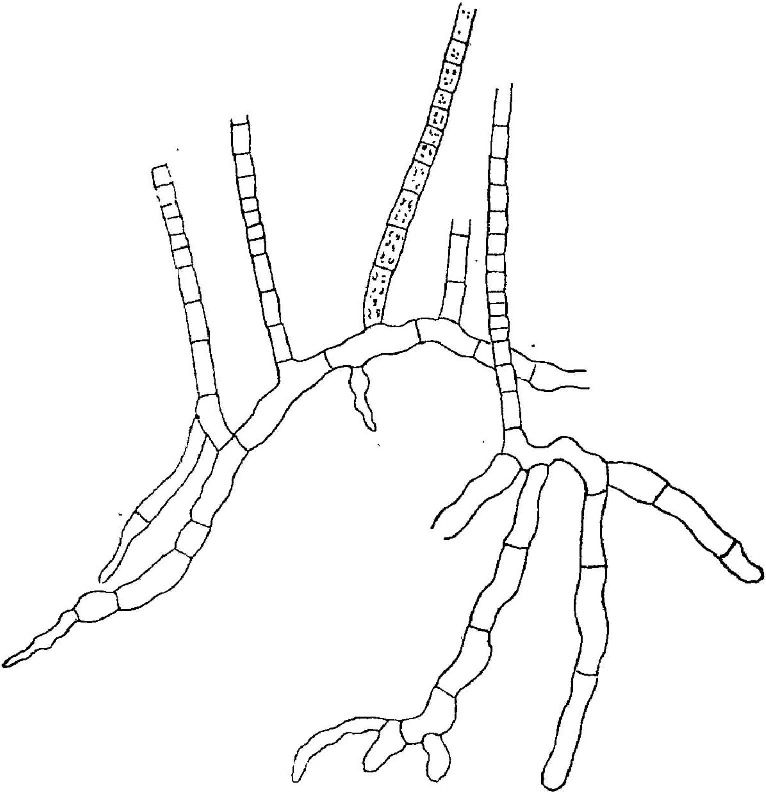


Fig. 6. *Ectocarpus thyrsoideus* Boergs. Basal parts of the plant. × 300.

of the host. From this large and complicated basal part the erect filaments are given out. They are composed of almost cylindrical cells somewhat constricted at the cross-walls about 18-25μ

thick and 1-6 times or more long. A zone of division is found somewhat above the base of the filaments in the young filaments, in the older ones it moves upwards to about the middle of the filaments and often becomes very long; above it the cells become slowly longer and longer and more and more destitute of

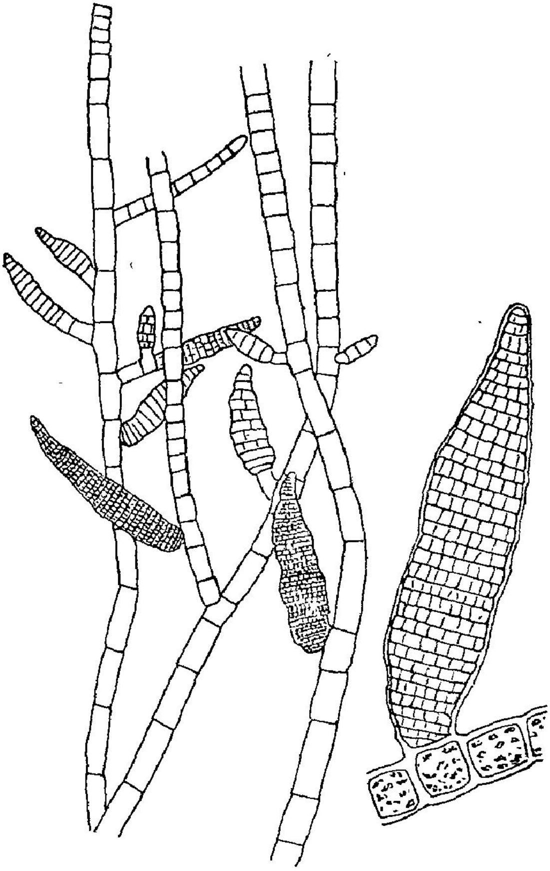


Fig. 7. *Ectocarpus thyrsoideus* Boergs. Filaments with plurilocular sporangia. × 300 and × 500.

chromatophores, and then die gradually in the upper ends of the filaments. The chromatophores are disc-shaped, irregularly strap-shaped or roundish.

Most of the filaments are unbranched ; only a few become branched and form single or a few branches.

The plurilocular sporangia are found scattered on the filaments. They are generally sessile, but occasionally pédicellate. They are more or less obliquely elongated, conical and irregularly constricted or sinuate up to about 140μ long and 25-35μ broad.

Since it resembled in several respects *Ectocarpus filifer* with which it was growing, I was at first not quite sure if they were not one and the same plant, but I have come to the conclusion that they must be kept apart. *Ectocarpus filifer* is a smaller plant which generally has terminally placed sporangia, which are not found in *Ectocarpus thyrsoideus*, and the sporangia placed on the assimilating filaments were more rare, whereas they were found only on the assimilating filaments in *Ectocarpus thyrsoideus*. An examination of the living material will certainly decide this question.

7. **Ectocarpus geminifructus** nov. sp.

Thallus ad 250μ altus ex filamentis endophyticis irregulariter ramosis, in thallo hospitis (*Liagora erecta*) repentibus, et filamentis erectis assimilatoriis, pilis et sporangiis libere emergentibus compositus. Fila endophytica inter filamenta assimilatoria hospitis circumvagabunda, ca. 7-12μ lata ex cellulis usque duplo longioribus sæpe longitudinaliter divisis formata. Filamenta erecta ad 250μ alta divisione intercalare crescentia superne aut obtusa aut pilifera., ca. 9-11μ lata, ex cellulis longitudinis eiusdem aut plus minus longioribus, sæpe longitudinaliter divisis, et chromatophora 3-6 disciformia continentibus. Pili ca. 8-9μ lati. Sporangia plurilocularia saccata, superne late rotundata, ca. 70μ longa et 27μ lata, in apicibus filamentorum brevium procrescentia, sæpe geminata extant.

India: Mahabalipuram (The Seven Pagodas) in *Liagora erecta*, leg. M. O. P. I.

The basal part of this interesting *Ectocarpus* (figs. 9, 10) is endophytic and composed of irregularly bent ramified filaments creeping round in the slimy calcified mass surrounding the assimilating filaments of the host. From this basal part the assimilating shoots, hairs and sporangia issue above the surface of the host. Especially characteristic of this species are the numerous longitudinal walls found not only in the endophytic

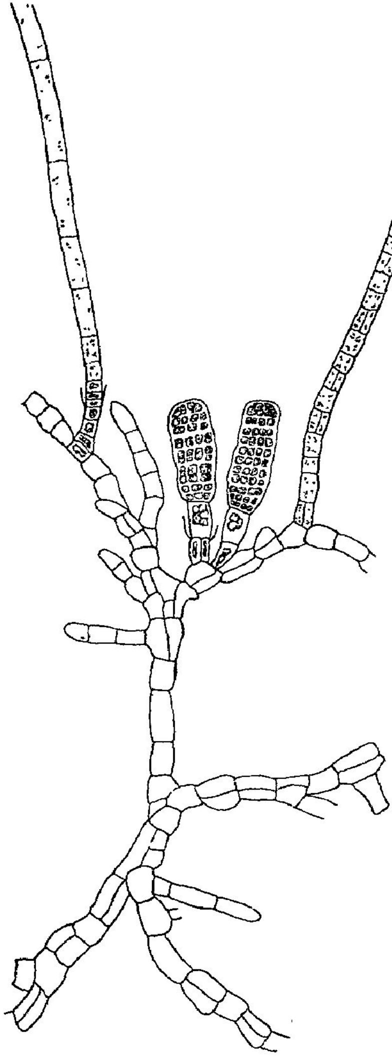


Fig. 8. *Ectocarpus geminifructus* nov. sp. Part of the thallus with plurilocular sporangia, assimilating filament and a hair. × 375.

filaments but also in the erect assimilating ones. And another characteristic feature is that the plurilocular sporangia often occur in pairs.

The creeping endophytic filaments are about 7-12μ thick and are composed of a row of cells nearly half of which are often divided by longitudinal walls into two cells. From this base the assimilating shoots, the hairs and the sporangia arise. The assimilating shoots vary in length, and are about 250μ long and often end in a hair, at the base of which a sheath is present. The assimilating shoots are about 9-11μ broad and the cells of which they are composed are as long as broad, the cells being often divided by longitudinal walls. The hairs which issue from the creeping filaments have a sheath at their base above which the zone of division is found. They are about 8-9μ thick.

The plurilocular sporangia are cylindrical-saccate in shape with broadly rounded apices and bases and are about 70μ long and 27μ broad. They are terminally placed on a more or less short filament which sometimes consists of a single cell only. When two sporangia are found together, the cells in the upper end of the filaments are divided by longitudinal walls, and at the top these cells are separate, each carrying a sporangium, reminding one of what sometimes takes place in *Ectocarpus terminalis* (compare my figures 27b, c, and 28a in Mar. Alg. from the Canary Islands, Part II, Phæophyceæ in Biol. Meddelelser, VI, 2, Koebenhavn, 1926, p. 53-55.)

The many peculiar longitudinally divided cells of this species reminds one of *Streblonema patagonicum* Skottsberg (Botanische Ergebnisse der Schwed, Exped. nach Patagonien in K. Svenska Vetenskapsakademiens Handlingar, Bd. 61, No. 11, Stockh. 1921, p. 11, fig. 5), but otherwise there are many differences, e.g., the presence of assimilating filaments above the surface of the host in the Indian plant, the shape of the sporangia, etc. Compare also the following species.

Hamelella a new Genus

8. Ectocarpus Dermonematis nov. sp.

Thallus endophyticus ex filamentis decumbentibus irregulariter ramosis in thallo hospitis (*Dermonema gracile*) repentibus et ex filamentis erectis brevibus assimilatoriis, pilis et sporangiis compositus.

Filamenta endophytica ca. 5-8-10μ lata ex cellulis 2-3 plo longioribus interdum longitudinaliter divisis formata. Filamenta assimilationis brevia ad 100μ alta, superne obtusa aut raro pilifera, ex cellulis ca. 8μ lata et longa, interdum longitudinaliter divisis et chromatophora 3-5 rotundata continentibus composita.

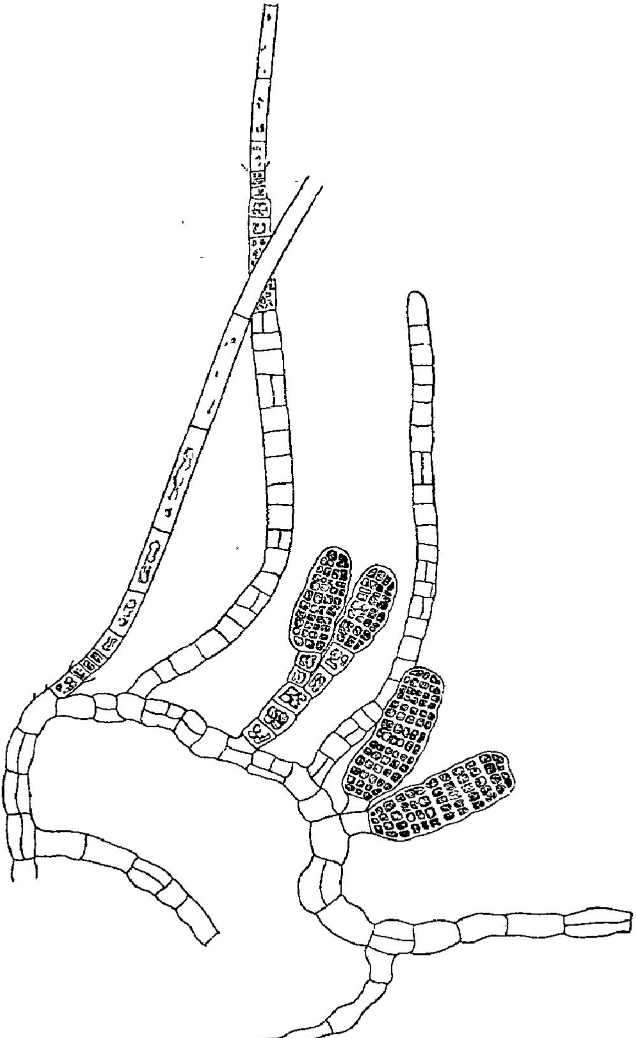


Fig. 9. *Ectocarpus geminifructus* nov. sp. Part of the thallus with plurilocular sporangia, assimilating filaments, one of which with a terminal hair and another hair. × 530.

Pili non numerosi, ca. 5μ lati. Sporangia plurilocularia late-ovalia-saccata, ca. 23-42μ longa et 13-17μ lata adsunt.

India: Cape Comorin, Oct. 1924, leg. M. O. P. I.

In the thallus of *Dermonema gracile* a small endophytic *Ectocarpus* (figs. 10, 11) was found the filaments of which were growing in between the assimilating filaments of the host and sending up short assimilating shoots, hairs and plurilocular sporangia. The plant appears to be nearly quite immersed in the tough mucilage of the host.

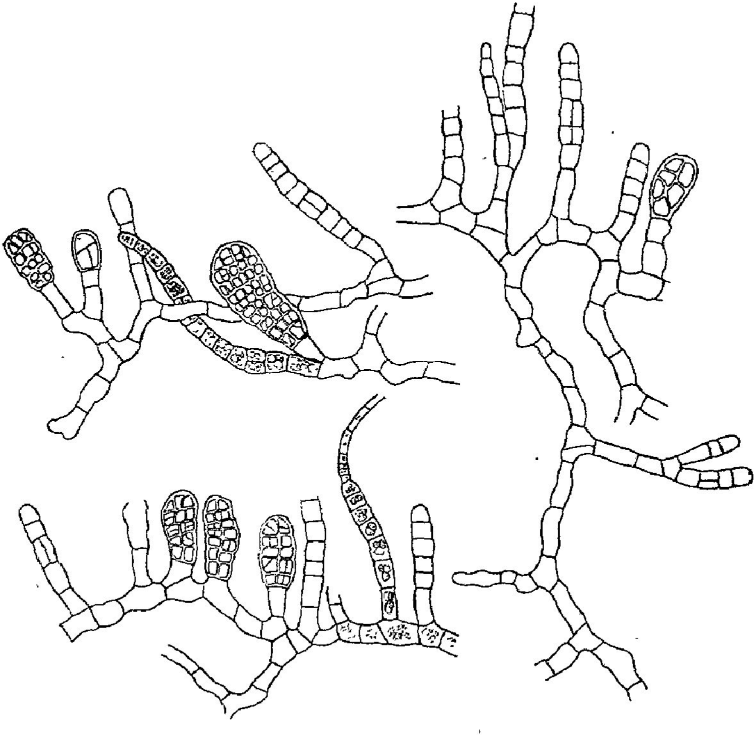


Fig. 10. *Ectocarpus Dermonematis* nov. sp. Parts of the plant with plurilocular sporangia and assimilating filaments, one with a terminal hair. × 450.

The *creeping filaments are irregularly bent and sinuate* and the cells also have more or less sinuate walls. The branching is quite irregular. The filaments in the thinner parts are about 5μ thick and in the thickest up to about 8-10μ; the length of the cells varies very much from as long as broad to 2-3 rarely

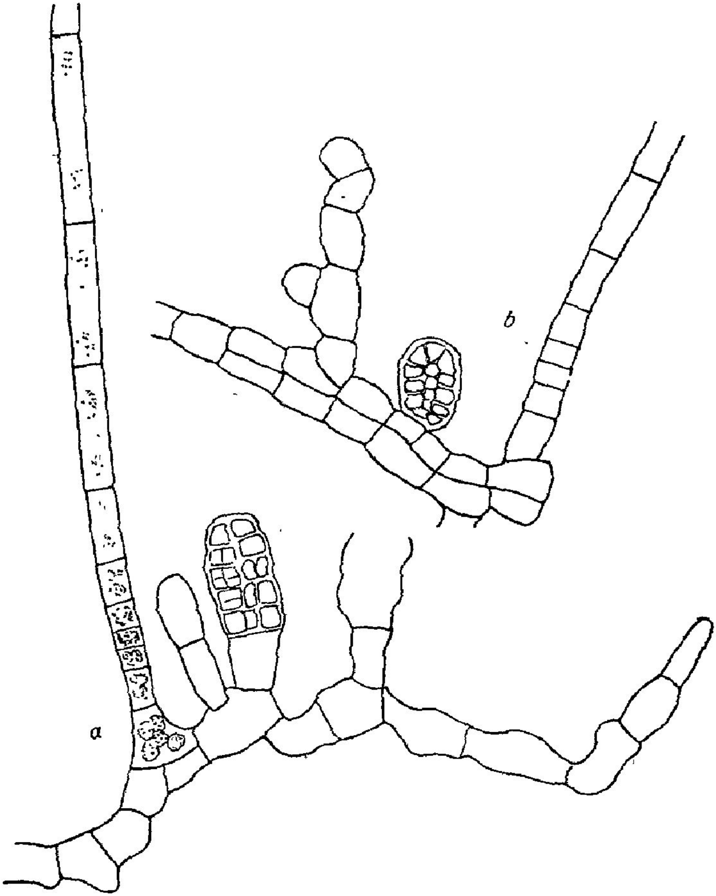


Fig. 11. *Ectocarpus Dermonematis* nov. sp. *a*, part of a plant with a plurilocular sporangium and a hair. *b*, part of an older plant with more longitudinally divided cells. × 800.

4 times as long as broad. The transverse walls are often more or less oblique; now and then when a sporangium or an assimilating filament grows out, the cells are divided by longitudinal walls into two cells. In old parts of the thallus, longitudinal walls are often rather common. The assimilating filaments are about 50-75μ or, very rarely, up to 100μ long or slightly longer and about 8μ broad; they are composed of rather short cells about as long as broad; now and then one of the cells is divided by a longitudinal wall. Most of the filaments end in a broadly rounded cell and sometimes though not often in a hair. The cells contain 3-5 roundish chromatophores. The hairs are not numerous; they have a zone of division near the base above which the cells gradually grow longer and colourless.

The plurilocular sporangia are broadly oval to saccate in shape, the smaller ones about 13μ broad and 23μ long, the larger about 42μ long and 17μ broad.

In many respects this species reminds one very much of *Ectocarpus geminifructus* described above. It grows in a similar way and has longitudinal walls and the shape of the sporangia shows much likeness. But it is smaller, and the sporangia are placed singly, though now and then a tendency to bifurcation is present. Because this plant seems to be nearly or quite immersed in the host, it ought perhaps have been referred to the genus *Streblonema*, but, since it is so very much like the preceding species, I keep it in the genus *Ectocarpus*. At any rate, these two species show that the limits of *Streblonema* from *Ectocarpus* are rather vague.

Streblonema Derb. et Sol.

1. **Streblonema turmale** nov. sp.

Thallus cæspites densos ca. 300-400μ altos formans. Filamenta decumbentia, endophytica inter filamenta hospitis (*Liagora erecta*) repentia, sparse ramosa, e cellulis irregulariter formatis ca.5-8μ latis et 1-3 et ultra longis composita. E filamentis decumbentibus periphericis sporangia plurilocularia, pili in superiore parte hyalini et filamenta assimilatoria oriuntur. Sporangia plurilocularia cylindrice-fusiformia, ca. 60μ longa et 4-8μ lata. Pili ca. ad 300μ et ultra longi et 4μ lati.

India: Mahabalipuram (The Seven Pagodas), leg. M. O. P. I.

On the old parts of the thallus of *Liagora erecta* Zeh a small *Streblonema* (figs. 12, 13) occurred forming low dense tufts near the surface of the host above which the colourless hairs protrude. The endophytic irregularly ramified filaments are creeping round about the assimilators of the host. They are composed of irregularly shaped cells about 5-8μ broad and 1-3 times as long. From the filaments approaching the surface of

the host, sporangia, hairs and assimilating filaments issue. The plurilocular sporangia are pedicellate or rarely sessile ; they are placed either singly one on each cell or sometimes are crowded together on short branch-systems in corymbiform manner. The sporangia are cylindrical-spindle-shaped, about 60μ long and 4-8μ broad. In the middle where they are broadest they are divided more or less by oblique walls. The hairs are about 4μ thick and 300μ long and have a growing zone near their base dying away upwards. The assimilating filaments are nearly cylindrical and may sooner or later be transformed into sporangia. The cells contain two to three small irregularly shaped roundish disc-shaped chromatophores.

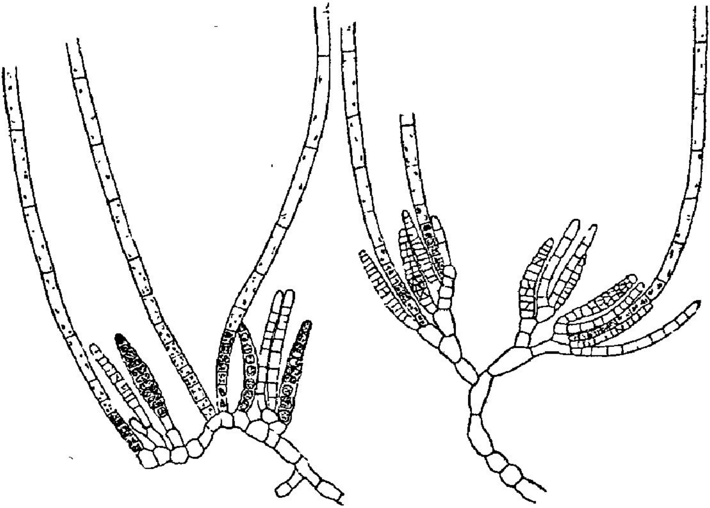


Fig. 12. *Streblonema turmale* nov. sp. Parts of the plants with plurilocular sporangia and hairs. $\times$ 400.

This little plant may remind one of *Streblonema corymbiforme* Setchell and Gardner in Phycological Contributions II-VI (University of California, Publications in Bot., vol. 7, 1922, p. 391) but in this species the sporangia have uniseriated loculi and hairs are absent. It is also closely related to *Streblonema tenuissimum* Hauck, Meeresalgen, p. 323, but this has only one row of loculi in the sporangia.

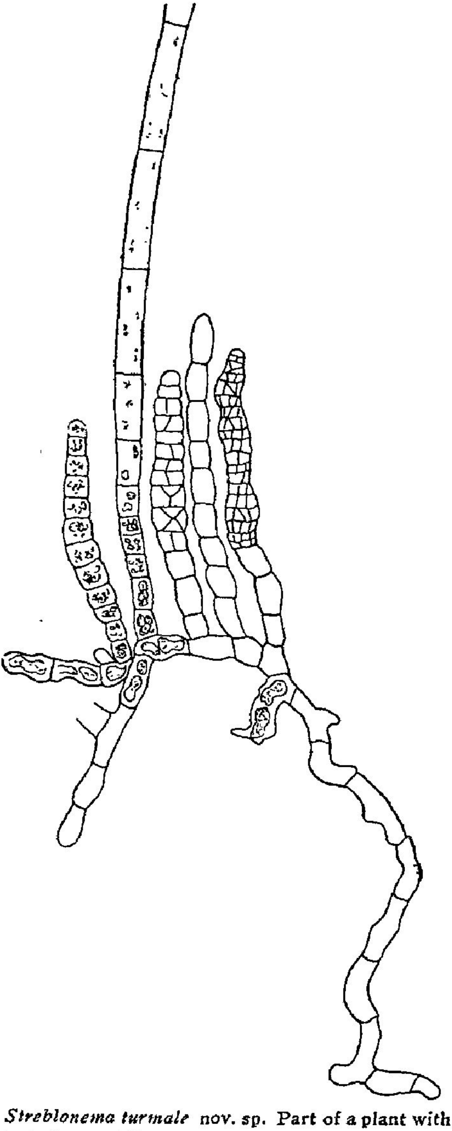


Fig. 13. *Streblonema turmale* nov. sp. Part of a plant with plurilocular sporangia and a hair. × 800.

Fam. 2. *Mesogloeaceæ.*

Sub-Fam. 1. *Myriogloceæ*

Myriogloea Kuck.

1. **Myriogloea sciurus** (Harv.) Kuck., Fragmente einer Monographie der Phaeosporeen, p. 62, fig. 81. BOERGESEN, in Journ. Ind. Bot. Soc., vol. XI, 1932, p. 63, fig. 6.

Since my paper quoted above was published, Miss PARKE has given a detailed description of this plant partly from the material sent to her by me. Compare her paper : A contribution to the knowledge of the Mesogloiaceæ and associated families (Publications of the Hartley Botanical Laboratories No. 9, Liverpool 1933). Whereas my material contained only plurilocular sporangia, Miss PARKE has found unilocular sporangia also in the material from South Africa.

The specimens now examined from South India likewise had only plurilocular sporangia. The specimens were gathered in October.

India : Cape Comorin, leg. M. O. P. I.

Distr.: India, Australia (N. S. Wales), Cape.

Fam. 3. *Scytosiphonaceæ.*

Rosenvingea Boergs.

1. **Rosenvingea intricata** (J. Ag.) Boergs. Cfr. BOERGESEN in Journ. Ind. Bot. Soc., vol. IX, 1930, p. 167.

The specimens form spongy masses.

India: Tuticorin: Hare Island,!

Distr.: Vera Cruz, Samoa, Australia, West Indies, etc.

2. **Rosenvingea orientalis** (J. Ag.) Boergs. Cfr. BOERGESEN, l.c., p. 168.

The shape of the specimens varies very much.

India : Tuticorin, Oct. 1923, leg. M. O. P. I.

Distr.: Indian Ocean, Formosa.

Fam. 4. *Encoeliaceæ.*

Hydroclathrus Bory.

1. **Hydroclathrus clathratus** (Bory) M. A. Howe in BRITTON and MILLSPAUGH, The Bahama Flora, New York, 1920, p. 590.

I n d i a: Tuticorin,! Shingly Island, leg. M. O. P. I.; Cave Matres, leg. M. O. P. I.

D i s t r.: Most tropical seas.

II. Sphacelariales.

Fam. 1. *Sphacelariaceæ.*

Sphacelaria Lyngb.

1. Sphacelaria furcigera Kütz. Tab. Phycolog., vol. V, p. 27, pl. 90, fig. II. SAUVAGEAU, Remarques sur les Sphacélariacées, p. 145. (Journal de Botanique, vol. XV, 1901).

Several tufts with propagula were found on old stems of *Turbinaria.*

I n d i a: Krusadi Island, Oct. 1925, leg. M. O. P. I.

D i s t r.: Widely spread in temperate and warm seas.

III. Dictyotales.

Fam. 1. *Dictyotaceæ.*

Stoechospermum Kütz.

1. Stoechospermum marginatum (Ag.) Kütz. Cfr. BOERGESEN in Journ. Ind. Bot. Soc., vol. XI, 1932, p. 67, fig. 8.

Most of the specimens gathered at the end of February were sterile; a single specimen from the beginning of March and another one from the middle of this month were fruiting.

I n d i a: Malvan, S. C. DIXIT; Karvar!; Tuticorin!

D i s t r.: India, Red Sea, Ceylon.

Padina Adans.

1. Padina tetrastromatica Hauck. Cfr. BOERGESEN in Journ. Ind. Bot. Soc., vol. IX, 1930, p. 172.

I n d i a: Cape Comorin, leg. M. O. P. I.

D i s t r.: Somaliland, India, Malayan Archipelago.

Dictyopteris Lamx.

1. D. delicatula Lamx. in Journ. Philom. 1809, No. 20, tab. 6, fig. B. cfr. BOERGESEN, Mar. Alg. D.W.I., vol. I, 1913-14, p. 216, figs. 166-7, where more literature is quoted.

At Tuticorin only sterile plants were found. The dredging was done in 2-3 fathoms of water.

India: Tuticorin, Hare Island!; Cape Comorin, leg. M. O. P. I.

Distr.: West Indies, Mexico, Brazil, Malayan Archipelago, etc.

Dictyota Lamx.

1. **Dictyota Bartayresiana** Lamx. Cfr. BOERGESEN, Mar. Alg. Arab. Sea, p. 29.

A specimen in IYENGAR's collection is a female one, having the oogonia spread over the thallus.

India: Krusadi Island, Pamban, May 1924, leg. M. O. P. I.

Distr.: West Indies, Indian Ocean, Australia.

2. **Dictyota dichotoma** (Huds.) Lamx. forma *implexa* (Lamour.) J. Ag. *Dictyota implexa* Lamour., Essai . . . Thalassiophytes, 1813, p. 58. DELILE, Flore d'Egypte, p. 149, pl. 56, fig. 5.

The specimens found resemble DELILE's figure. They are fruiting. The fructiferous organs are found in the middle of the thallus leaving a narrow sterile margin on both sides of it.

India: Tuticorin: Hare Island, leg. M. O. P. I.

Distr.: Mediterranean Sea, Atlantic Ocean, West Indies, Red Sea, etc.

3. **Dictyota atomaria** Hauck. Cfr. BOERGESEN in Journ. Ind. Bot. Soc., vol. XI, 1932, p. 69, figs. 9-10, pl. 2.

An old specimen and a young one are found. The specimens agree very well with some small specimens from Bombay.

India: Tuticorin,!.

Distr.: Bombay.

IV. Fucales.

Fam. I. ***Fucaceae***

Cystophyllum J. Ag.

1. **Cystophyllum muricatum** (Turn.) J. Ag. Cfr. BOERGESEN, Mar. Alg. Arab. Sea, p. 29.

The specimens found belong to the typical form.

India: Tuticorin, Hare Island!. Pamban, Krusadi Island, Oct. 1916 and Oct. 1924, leg. M. O. P. I.

Distr. India, Malayan Archipelago, Australia.

RHODOPHYCEÆ

A. Protofloridew.

I. Bangiales.

Fam. 1. ***Bangiaceæ.***

Erythrotrichia Aresch.

1. **Erythrotrichia carnea** J. Ag. Cfr. BOERGESEN in Kew Bulletin, 1932, p. 113.

It was found on *Spathoglossum asperum.*

India: Tuticorin, February 1921, leg. M.O.P.I.

Distr. Atlantic Ocean, Mediterranean Sea, Indian Ocean, Pacific coast of America, etc.

B. Florideæ.

I. Nemalionales.

Fam. 1. ***Chantransiaceæ.***

Acrochaetium Nägl.

As is well known, the two genera *Acrochaetium* and *Rhodochorton* seem to be closely related and censequently have been united by some investigators, and the numerous species of *Acrochaetium* have been referred to *Rhodochorton.* Concerning this question, see especially KATHLEEN M. DREW, "A revision of the genera *Chantransia, Rhodochorton* and *Acrochaetium,* with descriptions of the marine species of *Rhodochorton* (Naeg.) gen. emend, on the Pacific coast of North America" (University of California Publications in Botony, vol. 14, No. 5, 1928) and *Rosenvinge, L. Kolderup,* "Distribution of the Rhodophyceæ in Danish Waters" (D. Kgl. Danske Vidensk. Selsk. Skrifter, Naturv. og math. Afd., 9, Række VI 2, Koebenhavn 1935). As all problems concerning this intricate question have not yet been solved, I prefer to maintain the genus *Acrochaetium.*

As pointed out by BORNET in his valuable paper, "Deux *Chantransia corymbifera* Thuret. *Acrochætium* et *Chantransia,*" in Bulletin Soc, bot. France, tome 51, 1904, the development and structure of the basal part of the species in this genus is of great systematic value when classifying these small species which are often rather alike.

1. **Acrochaetium Dwarkense** Boergs., in Kew Bulletin, 1932, No. 3, p. 114, fig, 2.

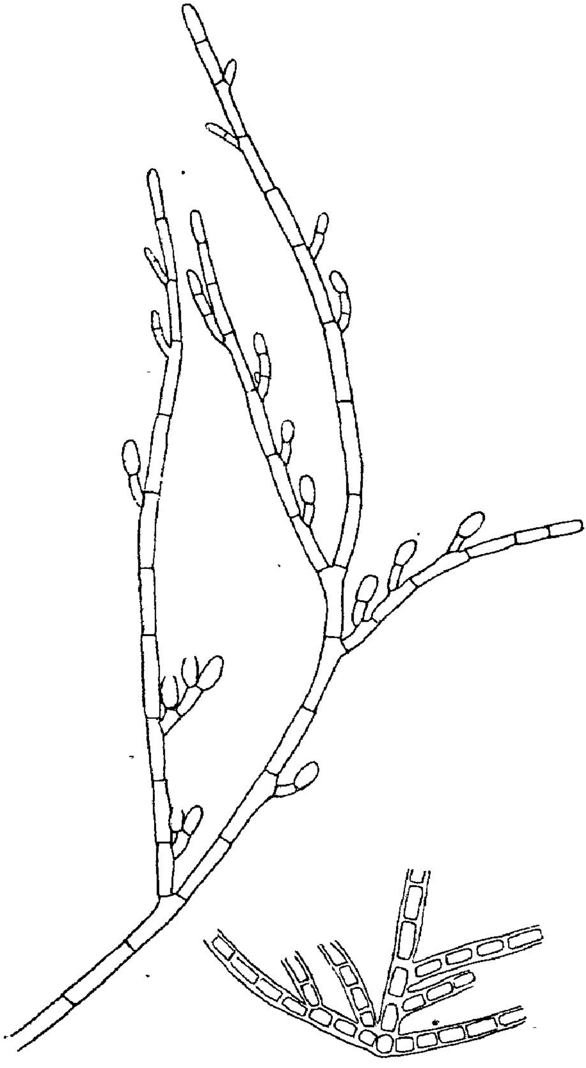


Fig. 14. *Acrochaetium Spathoglossi* nov. sp. *a*, base of a plant. *b*, upper end of an erect filament. × 750.

This fine little species occurred in masses along the edges and now and then also on the flat sides of *Padina tetrastromatica*.

India: Karvar, February 1928, leg. M. O. P. I.

Distr.: Dwarka.

2. Acrochaetium spathoglossi nov. sp.

Thallus ca. 300μ altus. Spora germinans, in cuticula hospitis plus minus immersa, sursum fila erecta et suberecta emittens. Fila sparse ramosa ex cellulis in inferiore parte ca. 5μ latis et 6-10μ longis in superiore ca. 3-4μ latis et 20-25μ longis. Monosporangia pedicellata aut in ramulis bi-tri-cellularibus sessilia ca. 7μ longa et 3-4μ lata.

India: Tuticorin, on the thallus of *Spathoglossum asperum*, February 1921, leg. M. O. P. I.

This small plant (fig. 14) reaches a height of about 300μ From the basal cell which appears to be somewhat sunk into the cuticle of the host several filaments arise ((fig. 14, *a*). The main filament given off from the upperside of the basal cell is erect whereas those issuing from the sides of the basal cell are at first more or less prostrate bending gradually upwards. The basal cell is about 5μ broad, and the cells next to it in the filaments are likewise short increasing slowly in length upwards. Higher up in the filaments the cells are 3-4μ thick and about 20-25μ long. The cells contain a parietal often deeply divided chromatophore with a rather large pyrenoid. The ramification of the filaments begins near the base. The branches are scattered and given out irregularly at different intervals. The monosporangia are pedicellate or rarely sessile. The pedicellate sporangia occur on the main filaments and branches, the sessile sporangia on short branchlets with two or three cells. The monosporangia are oval-oblong in shape and about 7μ long and 3-4μ broad.

The base of this plant reminds one of *Acrochaetium dwarkense* Boergs. (in Kew Bull. 1932, p. 114), but this species is more robust with thicker cells and opposite branches.

3. Acrochaetium Tuticorinense nov. sp.

Thallus cæspitosus usque ad 500μ altus, e disco basali parvo unistrato et filis erectis ramosis compositus. Fila erecta sparse ramosa e cellulis 7-9μ crassis et ad 25μ longis, chromatophorum parietale pyrenoide instructum, continentibus composita. Pili longi adsunt. Monosporangia sessilia, obovate-ellipsoidea, alternantia aut opposita, 17μ longa et 7μ lata.

India: Tuticorin on a piece of a sea-grass, leg. M. O. P. I.

On an old piece of a sea-grass, a small *Acrochaetium* (figs. 15, 16) was found. Its base consisted of a small roundish disc composed of a single layer of cells developed from the original

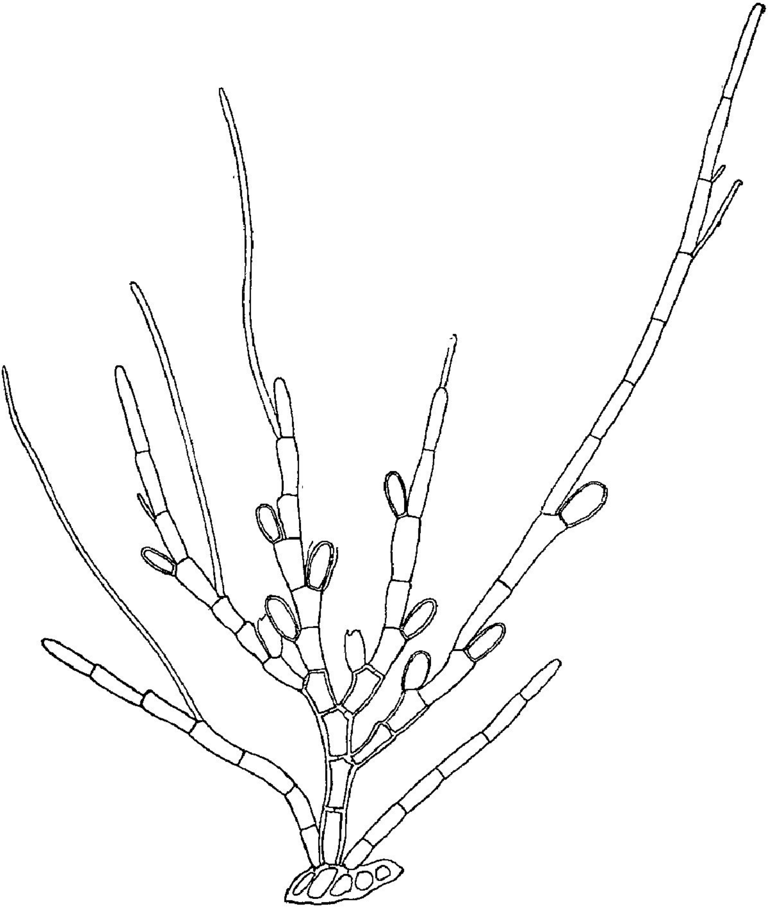


Fig. 15. *Acrochaetium Tuticorinense* nov. sp. Habit of a plant with monosporangia. × 600.

spore. From this disc the erect filaments arise and as several filaments are often given off, the plant forms small tufts reaching a height of about 500μ or more. The erect filaments near the base have cells with thick walls and the cells become a little thicker at the upper ends, being about 7-8μ thick at their base and about 9-10μ at their upper end. Higher up in the filaments the cells become gradually thinner, and at the same time cylindrical, the uppermost cells being only about 4-5μ thick. In the basal part the cells are about 15μ long, in the upper terminal parts about 25μ long. The cells contain a parietal plate-shaped chromatophore with a pyrenoid. Hairs are given off now and then from the cells. Vigorous branches are provided with scattered, rarely opposite, branchlets. The monosporangia are sessile, ellipsoidal-subcylindrical about 17μ long and 7μ broad. A single sporangium or often two oppositely placed ones are formed at the upper ends of the cells. When a sporangium has been emptied a new one is often developed. The upper ends of the filaments have thin, long and cylindrical cells and are bare without any branches or sporangia.

This *Acrochaetium* shows a certain amount of resemblance to *Acrochaetium canariense* Boergs. in Mar. Alg. Canary Islands, III Rhodophyceæ, part 1, 1927, p. 17-21, figs. 9-11; but the Canarian plant is nevertheless very different. Thus for instance the cells are shorter, the sporangia often pedicellate, and tetrasporangia are often present.

4. Acrochaetium Krusadii nov. sp.

Thallus cæspitosus ca. 300μ altus ex filis repentibus in thallo hospitis (*Dictyota Bartayresiana*) epiphyticis et ex filis erectis ramosis compositus. Fila repentia ex cellulis brevibus ca. 6-7μ longis et 5μ latis formata. Fila erecta in parte basali simplicia, in superiori parte plus minus ramosa, ramos sparsos breves gerentia. Cellulæ cylindricæ in parte basali 4-5μ latæ et 12-13μ longæ ad apicem versus ca. 3½-4μ latæ et 17-19μ longæ. Monosporangia pedicellata aut raro sessilia, oblonga, 8μ lata et 12μ longa.

India: Krusadi Island, May 1924, leg. M.O.P.I.

On old parts of the thallus of *Dictyota Bartayresiana* a small *Acrochaetium* (figs. 17 to 19) with creeping basal filaments was found. It forms rather small dense tufts about 300μ high. The creeping filaments are composed of rather short, more or less barrel-shaped cells, about 6-7μ long and 5μ broad. From the cells of these creeping filaments, erect filaments which are not much branched arise. The latter are composed of cylindrical cells, which are about 4-5μ thick and 12-13μ long near the base tapering a little upwards to a thickness of about 3½-4μ. The length of the cells varies very much; generally the cells become a little longer upwards being about 17-19μ long, but filaments are found in which the cells near the summit are only about 8μ

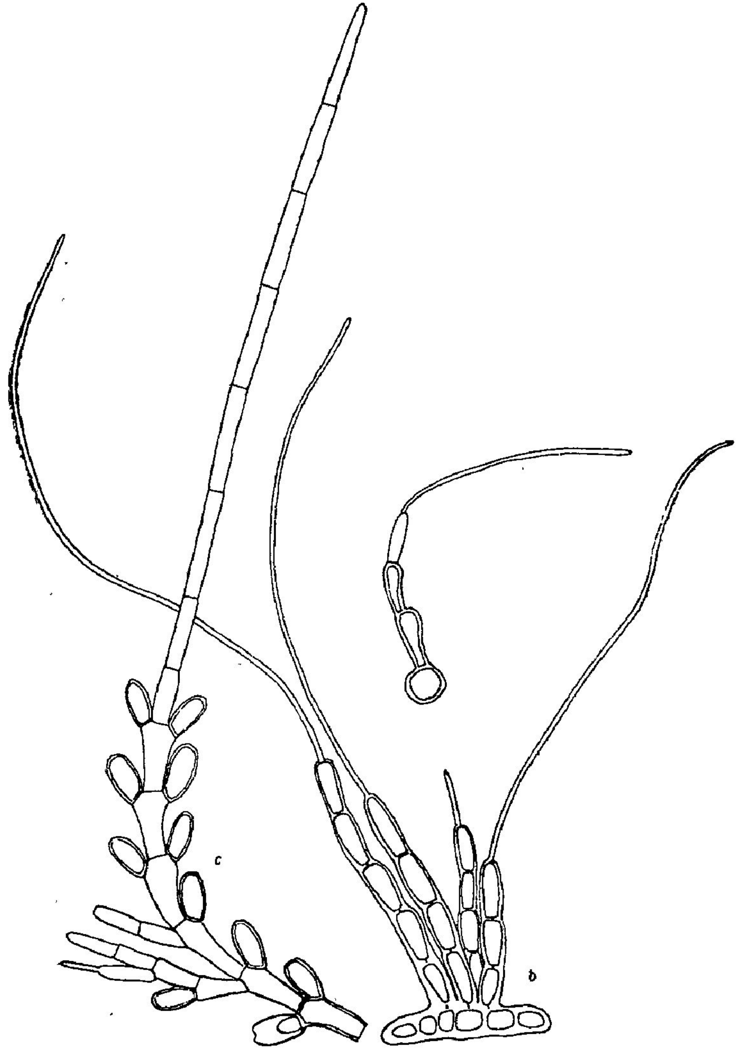


Fig. 16. *Acrochaetium Tuticorinense* nov. sp. *a*, a young plant. *b*, somewhat older plant. *c*, upper end of a filament with monosporangia. × 700.

long. Most of the filaments are unbranched, but some are provided with a few short branches. As a rule the sporangia are pedicellate or rarely sessile; often they are placed serially in long rows and sometimes alternately. The sporangia are proportionately large, oval, 8μ thick and 12μ long. The walls of the emptied sporangia become rather long, about 15-19μ; generally a new sporangium is developed from the bottom of the emptied one. No hairs are found.

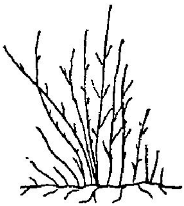


Fig. 17. *Acrochaetium Krusadii* nov. sp. Habit of plant. × 100.

The creeping basal filaments of this plant may remind one of *Acrochaetium Iyengarii* Boergs., in Kew Bulletin, 1933, p. 113, but in other respects the last mentioned plant differs very much from it, for instance, it has no hairs, the sporangia are often sessile and the basal filaments become coherent forming a disc.

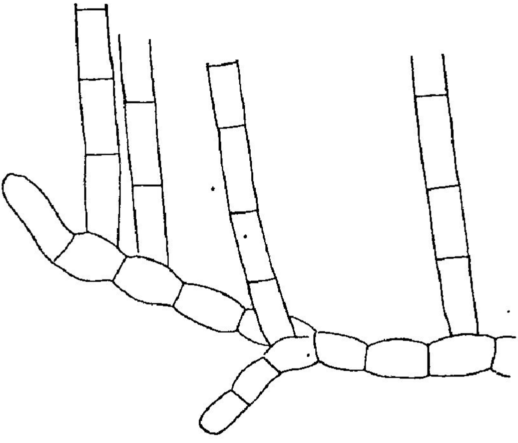


Fig. 18. *Acrochaetium Krusadii* nov. sp. Base of a plant. × 1400.

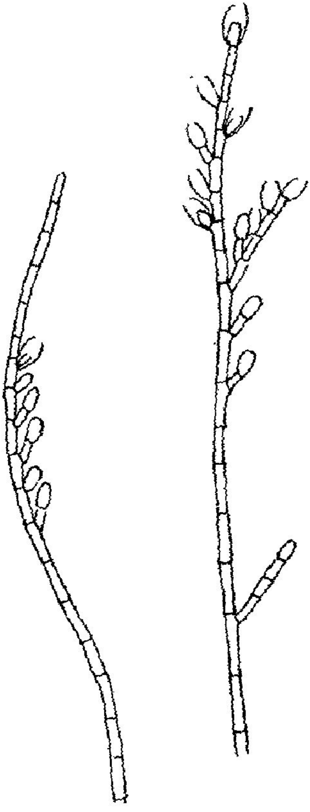


Fig. 19. *Acrochaetium Krusadii* nov. sp. Upper ends of erect filaments with monosporangia. × 500.

5. Acrochaetium liagoraefilum nov. sp.

Thallus cæspitosus, usque ad 300-400μ altus. Spora in filamentis assimilationis hospitis (*Liagora erecta*) germinans, magna, ca. 12μ lata, subglobosa, ex parte inferiore fila decumbentia, endophytica, ex parte superiore fila erecta emittens. Fila endophytica circa filamenta assimilationis hospitis repentia e passim fila erecta sporangifera emittentia. Fila erecta, spars ramosa ex cellulis ad basin ca. 6-7μ latis et 2-3 plo latioribus,

apicem versus paullo attenuatis ca. 5μ latis. Monosporangia pedicellata, oblonge ovata, ca. 10-12μ longa et 5-7μ lata.

I n d i a : Mahabalipuram (The Seven Pagodas), leg. M.O.P.I.

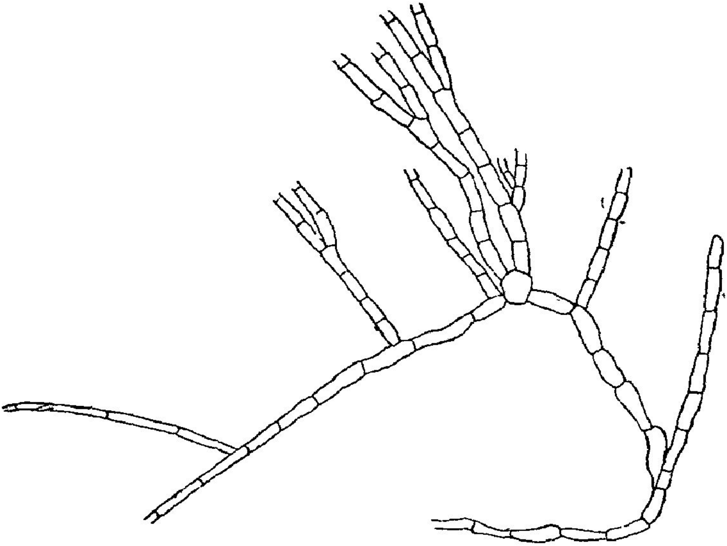


Fig. 20. *Acrochaetium liagoraefilum* nov. sp. From the spore (seen in the middle) erect filamentsand decumbent endophytic filaments issue. And from the latter erect filaments are given out. × 500.

On *Liagora erecta* Zeh this small *Acrochaetium* (figs. 20, 21) was found intermingled with other epiphytes forming small tufts about 300-400μ high. It has a spreading system of decumbent endophytic filaments creeping round about the assimilating filaments of the host and from which the erect filaments arise forming tufts above the surface of the host.

The germinating spore (compare fig. 20) is rather large about 12μ in diameter and sends out erect filaments from its upper side and decumbent creeping ones from near its base. The cells in the decumbent filaments are about 4-6μ broad and 3-5 times as long. The erect filaments at the base are about 6-7μ broad and 2-3 times as long; the filaments taper gradually upwards to a thickness of about 5μ near the top, and the cells also gradually become longer, about 22μ. The filaments and the main branches are branched. The branches are scattered. Only

monosporangia are found. These are placed terminally on pedicels consisting of one or two cells. The sporangia are oval-ovate in shape, and about 10-12μ long and 5-7μ broad.

The growth of this plant reminds one of that of *Acrochaetium* (*Chantransia*) *nemalionis* (De Not.) according to ROSENVINGE's very minute description in Mar. Alg. of Denmark, p. 126. (Kgl. danske Vid. Selsk. Skrifter, 7. Række, Naturv.-mathem. Afd. VII, 1. Koebenhavn 1909), but this plant is much larger and differs very much from the Indian plant in other respects as well.

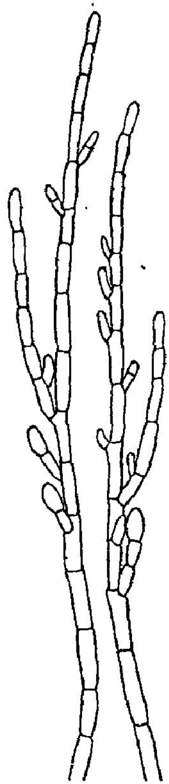


Fig. 21. *Acrochaetium liagoraefilum* nov. sp. Upper ends of erect filaments. × 500.

6. Acrochaetium multisporum nov. sp.

Præter sporangia tota planta endophytica e filamentis inter cellulas hospitis (*Halymenia floresia*) repentibus composita. Filamenta parce ramosa, ramos remellosos, breves, plus minus erectos gerentia.

Cellulæ plus minus cylindricæ aut sinuosæ vel interdum magis irregulares, ca. 5-10μ latæ et 3-4-10 plo longæ, chromatophorum latum parietale sæpe per totam longitudinem plerumque in duas, inderdum in plures partes divisum continentes. Sporangia terminalia, pyriformia, supra superficiem hospitis plus minus emergentia, ca. 22μ lata et 26μ longa, sporas numerosas continentia.

India: Pearl banks, near Tuticorin, leg. M.O.P.I.

In the soft loose thallus of a male plant of *Halymenia floresia* a part of the thallus was in some places infected with a peculiar small endophytic *Acrochaetium* (figs. 22, 23). The thallus consists

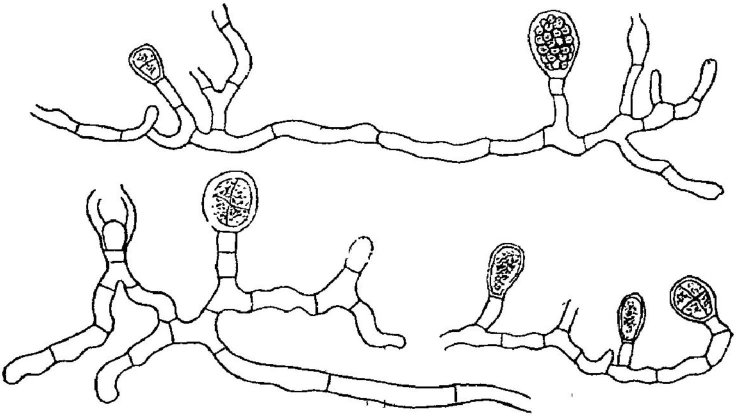


Fig. 22. *Acrochaetium multisporum* nov. sp. Part of the thallus with sporangia in various stages of development. × 400.

of an endophytic ramified system of branches inside the thallus of the host plant above the surface of which only the sporangia of the endophytic alga protrude. Its filaments are composed of cells which are rather long in the unbranched parts and rather short in the branched ones, the length of the cells varying from often not longer than the breadth up to several times the breadth. The cells are about 5-10μ broad and up to 75μ long, and sometimes even up to 100μ long. The filaments are often almost straight and these parts help to spread the plant round about in

the host; sometimes they are irregularly bent with short sinuous cells. From the creeping filaments systems of short branches are given out, the upper ends of which pierce the surface of the host and are transformed into sporangia. In an infected part of the thallus of *Halymenia*, the sporangia of the *Acrochaetium* are seen scattered over the surface. The cells contain a large parietal chromatophore which in many of the cells is divided longitudinally into two long ribbon-like bodies, and in the other cells are further divided transversely into smaller ones. No pyrenoid was observed, most probably because the material had remained too long in formalin.

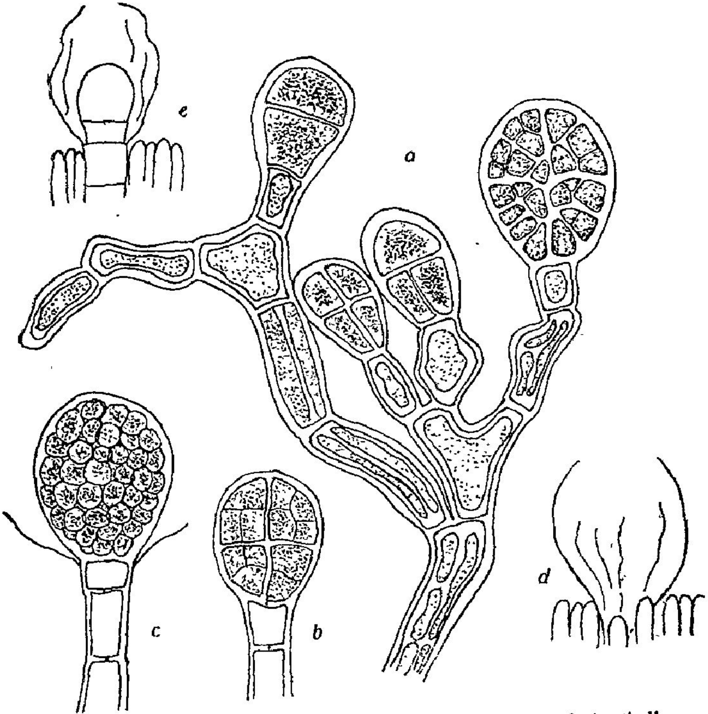


Fig. 23. *Acrochaetium multisporum* nov. sp. *a*, part of the thallus with sporangia in various stages of development. *b*, sporangium in division. *c*, a nearly ripe sporangium. *d*, an emptied sporangium surrounded by epidermal cells of the host. *e*, a new sporangium growing up in an emptied one. × 1100.

The terminally placed obovate-pyriform sporangia in the first place are divided by a transverse wall into two cells and then by longitudinal walls into four parts, which are again divided into a large number of small spores. When they are ripe they are emptied through a large hole in the upper end of the wall; empty sporangia were found here and there between the unemptied ones. When a sporangium is empty, a new one is often formed in the place of the old one. The sporangia are about 22μ broad and 20μ long.

As far as I know, polyspores in *Acrochaetium* have only been found once, namely, by Howe in *Acr. polysporum* Howe (Mar. Alg. of Peru, Memoirs of the Torr. Bot. Club., vol. XV, 1914, p. 88, pl. 31, figs. 1-11). But in no other respects do these two plants resemble each other.

In its method of growth, the Indian plant shows some likeness to *Acrochaetium Collinsianum* Boergs. in Mar. Alg. D. W. I., vol. II, p. 454 (Syn. *Acrochaetium liagorae* Boergs. l.c., p. 57, figs. 60-62); but otherwise the last mentioned species is very different, having for instance monosporangia only and hairs.

7. **Acrochaetium liagoroides** nov. sp.

Thallus ex parte majore endophyticus ex filamentis decumbentibus irregulariter ramosis inter filamenta assimilatoria hospitis (*Liagora erecta* Zeh) circumvagantibus et ex filamentis erectis, ramosis, tetrasporangiferis compositus. Filamenta decumbentia ex cellulis nunc subcylindricis, nunc plus minus fusiformibus, nunc medio plus minus irregulariter inflatis, ca. 4-6μ-13μ latis et 22-26μ longis, chromatophorum stellare pyrenoide centrali continentibus, constructa. Filamenta erecta plus minus repetite divisa, ex cellulis ad superficiem hospitis versus gradatim brevioribus et oblonge-rotundatis formata. Tetrasporangia, ex cellulis extremis filamentorum orta, oblonga, 12-13μ lata et 17-18μ longa.

India: Mahabalipuram (The Seven Pagodas), leg. M.O.P.I.

In *Liagora erecta* Zeh an endophytic *Acrochaetium* (fig. 24, 25) was found which I have called by the above mentioned name because of its very great likeness to the tissue of the host (compare fig. 25). When I first observed it, I must confess that I thought, intermingled as it was between the assimilating filaments of the host, that it belonged to the *Liagora*, and therefore supposed that I had found a species of *Liagora* with real true tetrasporangia. And it was not only the shape and the size of the filaments of the host and of the endophyte which were so very much alike, but the chromatophores also of both the plants resembled each other very much. Thus the chromatophores in *Liagora* as well as in *Acrochaetium* were very

feebly developed in the filaments creeping in the interior of the host, they consisted merely of a few long thread-like prolongations which issued at both sides from the pyrenoid in the middle of the cells, whereas in both the plants the chromatophores gradually increased in size and vigour in filaments approaching the surface of the host. But I still felt some doubt as to the matter

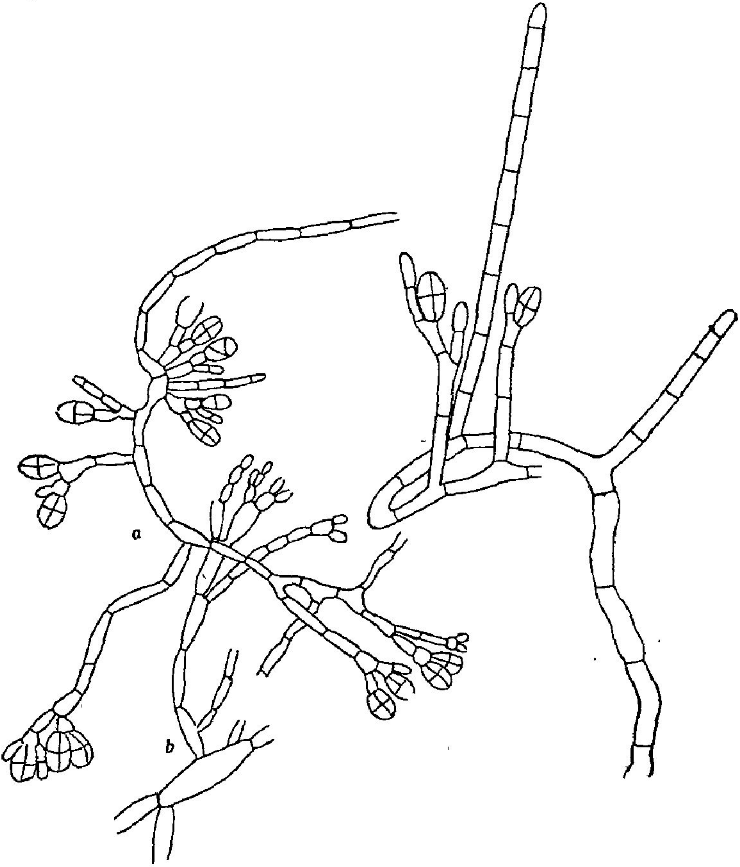


Fig. 24. *Acrochaetium liagoroides* nov. sp, *a*, part of thallus with tetrasporangia. *b*, a filament of *Liagora erecta*. *c*, part of the thallus with erect filaments. × 325.

and after having examined some fresh material I came across short filaments in some specimens and most probably these filaments have protruded above the surface of the host, and they quite resembled *Acrochaetium* having almost cylindrical cells and a large chromatophore filling nearly the whole cell (compare fig. 24*c*). But such filaments do not seem to be common. As a rule the upper ends of the filaments with tetrasporangia lie just near the

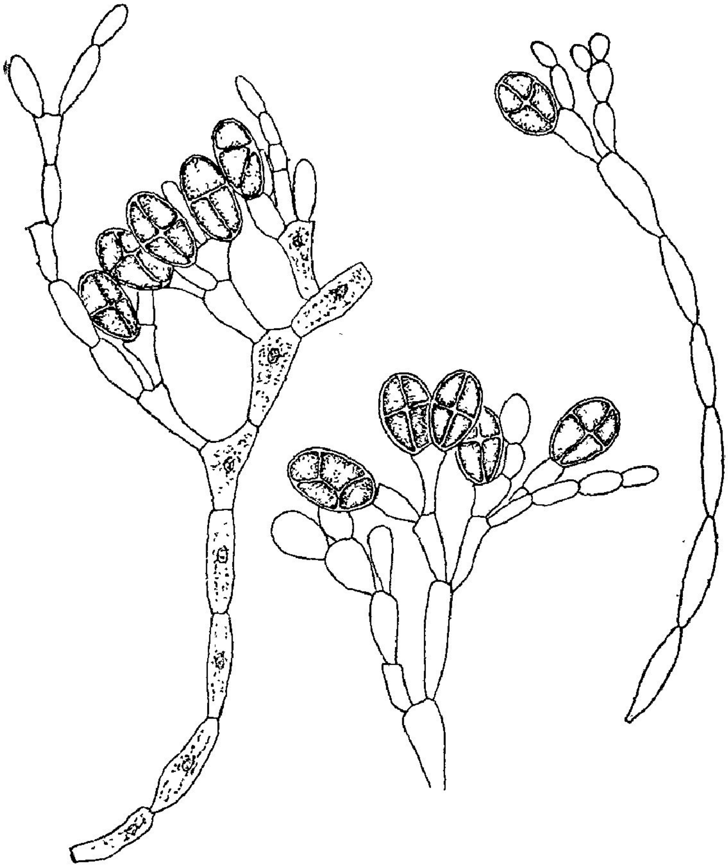


Fig. 25. *Acrochaetium liagoroides* nov. sp. Parts of the thallus with tetrasporangia. × 650.

upper ends of the assimilating filaments of *Liagora*. The filaments more deeply immersed in the tissue of the host are rather long, nearly cylindrical or fusiform, about 22-26μ long and 5-6μ at their thickest and about 4μ only at the ends. But thicker, irregularly shaped cells up to about 12-13μ are also found. Towards the periphery, the filaments generally increase in thickness, often up to about 12μ or more, while the cells become shorter and oval in shape. At the same time, the chromatophores become more vigorously developed as mentioned above. The few filaments protruding above the surface of the host have nearly cylindrical cells with a large parietal chromatophore covering the whole or almost the whole cell ; these cells are about 6μ thick and 2-4μ times as long.

The tetrasporangia are developed in the upper ends of the filaments. They are oval in shape, and about 17-18μ long and 12-13μ broad. They are cruciately or sometimes more irregularly divided. They are developed from the end cells in the filaments; when a sporangium is emptied, a new one may begin to grow out in the place of the old one.

Several species of *Acrochaetium* have been found on *Liagora*. Among these *Acrochaetium Collinsianum* Bœrgs. (Mar. Alg. D. W. I., vol. II, p. 454) seems to be related to this species. But the West Indian plant differs essentially from the Indian plant in having monosporangia only and also in having these monosporangia often placed directly on the creeping filaments either sessilely or pedicellately. Another difference is that hairs are present in the West Indian plant, while they are absent in the Indian plant.

Fam. 2. ***Helminthocladiaceae.***

Liagora Lamouroux.

Liagora erecta Zeh, Neue Arten der Gattung *Liagora* (in Notizblatt des Königl. bot. Gartens und Museums zu Berlin, V. Bd. 1913, p. 268).

When I refer some specimens in Professor Iyengar's collection to this species, I must point out that it is because the ramification of Zeh's plant seems to be the same as that of Iyengar's plants and because of the locality, Madras, being the same. By the courtesy of Dr. Otto Chr. Schmidt and the Direction of the Botanical Museum in Berlin-Dahlem, I was allowed to see the original specimen of this species. It consists only of a small piece about 9 cm. high of a main axis provided with a few scattered short branches. From the description of the locality, "Madras Beach," attached to the specimen, it is evidently a bit of a bleached specimen cast ashore on the extensive sandy coast at Madras. An examination of a small decalcified bit of it also shows that the upper ends of the

assimilating filaments are torn away more or less, but nevertheless, I think, the specimen is from a male plant, and the assimilating filaments, when compared with those in my specimens, seem to agree very well in shape and size. But I wish to point out that, in case this species was established on my material and I had to identify the original specimen of ZEH'S by means of it, I would feel a little doubtful.

During a visit to London just now at the end of March and the beginning of April 1936, Dr. TANDY allowed me to see the specimens of this species found in the British Museum. The small fragment found in Berlin was taken from one of the specimens. These specimens agree very well with mine, the only difference being that the lower branches were less developed.

The material which I have examined consists of a large dried male plant (see pl. I) and a few smaller female plants likewise dried (one of these seen to the right on the plate) and finally several pieces of specimens with numerous epiphytes preserved in formalin. The large male plant is 40 cm. high. Besides the main filaments two filaments almost as long and 5-6 short ones about 14 cm. long issue from the base. Both the main filaments and the other filaments from top to base are provided with short scattered branches, the lowermost reaching a length of about 14 cm., the remaining ones becoming gradually shorter upwards, the uppermost reaching only a length of ½-1 cm. The lowermost branches are ramified like the main filament. The plant has a dirty reddish-brown colour, but it is rather difficult to decide its real colour on account of the epiphytes with which it is covered.

The female specimens are much smaller being only 12 cm. high. In these several branches are likewise given off from the basal disc, and these branches are covered with short scattered branchlets. As regards the anatomy of the plant, it is built in the usual way as found in *Liagora*. After decalcification the assimilating filaments issuing from the medullary filaments are found to be composed of long fusiform cells becoming gradually shorter and thicker upwards and then decreasing a little near the periphery. In the female plant the basal cells of the filaments are especially long and thin and about 5-6μ thick; almost in the middle of them, where they begin to be a little thicker, the carpogonial branch is developed. Next to the external habit of the plant, the shape of the carpogonial branch seems to be one of the best characters to determine the species of this genus, whereas in my opinion the shape and size of the assimilating filaments vary very much even in the same species. The carpogonial branch (fig. 26 a, b) in this species is rather much curved in the basal part reminding one very much of the one found in *Liagora gymnarthron* Boergs. (Mar. Alg.

Can. Islands, III, 1, p. 56, fig. 31), but it is longer and thinner and about 5-6μ broad only. It consists of 4 cells, 3 short ones and a long straight carpogonium about 13-15μ long tapering gradually upwards and ending in the long thin trichogyne. The upper cells in the assimilating filaments are oblong about 5-8μ broad. The cystocarps form large globular bodies composed of the densely aggregated sporogenous filaments surrounded by a well developed involucrum composed of long thin incurved filaments.

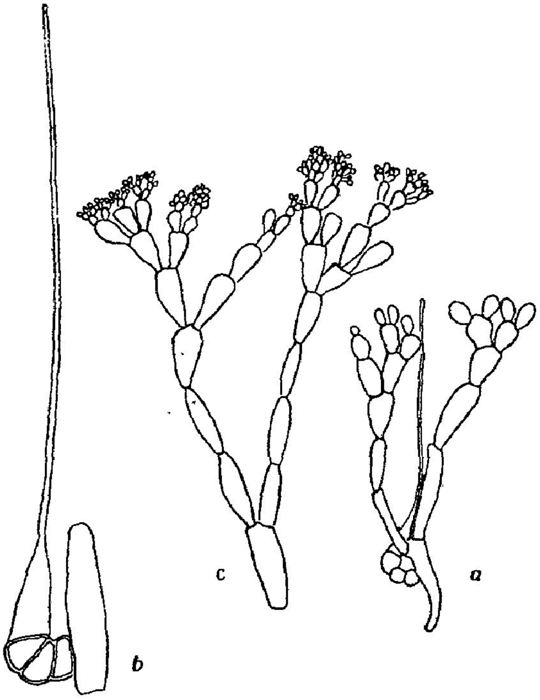


Fig. 26. *Liagora erecta* Zeh. *a*, assimilating filaments with carpogonial branch, *b*, a corpogonial branch more magnified. *c*, filaments with antheridia. *a*, *c*, × 500. *b*, × 800.

In the male plant the antheridia (fig. 26c) are formed at the ends of the assimilating filaments.

Neither in this species nor in those I have seen from India have I met with the peculiar endophytic organisms which were so common in some of the West Indian species of *Liagora* (compare my description and figures in Mar. Alg. D. W. I., vol. II, p. 455-8, fig. 421). But Mme. WEBER found them in *Liagora cheyneana* Harv. (=*Liagora farinosa* Lamx.) as mentioned in her Liste des Algues du Siboga, p. 201. These bodies, which, I think, are independent organisms living in the tissue of the *host*, are supposed by HOWE to be monosporangial discs (compare HOWE's paper, Observations on monosporangial discs in the genus *Liagora* in Bull. Torr. Bot. Club, 47, p. 1-8, pl. 1, 1920).

The plant was found in a very exposed locality in the month of January.

India: Mahabalipuram (The Seven Pagodas), leg. M.O.P.I.

Distr.: Madras.

II. Gelidiales.

Fam. I. ***Gelidiaceae.***

Gelidium Lamour.

1. **Gelidium corneum** (Huds.) Lamour. Cfr. BOERGESEN in Kew Bull. 1934, No. 1, p. 5.

Some specimens agree with my figure in Mar. Alg. D.W.I., vol. II, p. 115, fig. 124; others are very like KÜTZING's figure in Tab. Phyc., vol. 18, pl. 59, called *Gelidium micropterum*.

India: Carvar, Bengi Bay, !.

Distr.: Widely spread in warmer seas.

III. Cryptonemiales.

Fam. 1. ***Rhizophyllidaceae.***

Chondrococcus Kütz.

1. **Chondrococcus Hornemanni** (Mert.) Schmitz. in Engl. Bot. Jahrb. XXI, p. 170, 1895. BOERGESEN in Kew Bull., 1933, No. 3, p. 117.

India: Cape Comorin, leg. M.O.P.I.

Distr.: Indian Ocean.

Fam. 2. *Corallinaceae.*

Amphiroa Lamour.

1. Amphiroa anceps (Lamk.) Decne. Cfr. BOERGESEN in Kew Bull., 1934, p. 7.

India: Carvar,!; Cape Comorin (a form with a more narrow thallus), leg. M.O.P.I.

Distr.: India, South Africa, Malay Archipelago, Japan, West Australia.

Fam. 3. *Grateloupiaceae.*

Halymenia C. Ag.

1. Halymenia floresia (Clem.) Ag., Spec. Alg. I, p. 209 J. AGARDH, Spec. Alg. II, p. 205; Epicrisis, p. 138.

A few fine specimens were collected by IYENGAR from pearl oyster banks near Tuticorin and from Chank Fisheries banks near Rameswaram.

Distr.: Warmer Atlantic Ocean, Mediterranean Sea, West Indies, Malayan Archipelago.

IV. Gigartinales.

Fam. 1. *Solieriaceae.*

Soliera J. Ag.

1. Soliera robusta (Grev.) Kylin. Cfr. BOERGESEN in Kew Bulletin, 1934, No. 1, p. 10.

Only a few cystocarpic specimens have been found; they were gathered at the end of February.

India: Tuticorin!

Distr.: Australia, Japan, Malayan Archipelago, India.

Fam. 2. *Hypneaceae.*

Hypnea Lamour.

1. Hypnea musciformis (Wulf.) Lamour. Cfr. BOERGESEN in Kew Bull. 1934, p. 17, for more literature.

India: Tuticorin, leg. M.O.P.I.

Distr.: Most warm seas.

2. Hypnea valentiae (Turn.) Mont. Cfr. BOERGESEN in Kew Bull. 1934, p. 17.

HAUCK in Hedwigia, 26, 1887, p. 20, has pointed out that several species formerly considered separate, namely, *H. seticulosa*

J. Ag., *Hypnea divaricata* Kütz., *Hypnea charoides* Lamx. and others, are to be referred to *Hypnea valentiae* (Turn.) Mont. (*Fucus valentiæ* Turner, "Fuci," tab. 78, vol. II, 1809). In the paper quoted above I have followed HAUCK. In my material some specimens resemble very much LAMOUROUX's figure of *Hypnea charoides* (Essay . . . Thalassioph., 1813, pl. X, figs. 1-3); but other specimens are intermediate and vary much as to appearance. In some specimens (No. 5619 from Karvar) the branches are very much divaricate and under the acute summits they quickly become covered with densely placed short ramuli spreading on all sides and resembling very much the plant OKAMURA has described in his Algæ Jap. Exsiccatæ, No. 62, and named *Hypnea seticulosa*. This specimen forms a transition to the form which in Kew Bull. 1934, p. 18, though with reservation, I have referred to *Hypnea spicifera* and which, as pointed out there, is very like *Hypnea Harveyi* Kütz., Tab. Phycol., vol. 18, pl. 28.

India: Karvar, Bengi Bay!

Distr.: Most warm seas.

Fam. 3. *Gracilariaceae.*

Gracilaria Grev.

1. Gracilaria compressa (Ag.) J. Ag., Spec. Alg., p. 593. Epicrisis, p. 417. *Sphaerococcus compressus* Ag. Spec. Alg., p. 308.

A female specimen resembles very much KÜTZING's figure of *Sphaerococcus compressus* in Tab. Phyc., vol. 18, pl. 78 and of *Sphaerococcus vagus*, pl. 76.

India: Cape Comorin, leg. M. O. P. I.

Distr.: Warm Atlantic Ocean, Mediterranean Sea, etc., most warm seas.

2. Gracilaria foliifera (Forssk.) Boergs., Revision of FORSSKAAL's Algae in Dansk Bot. Arkiv, Bd. 8, 1932, p. 7, fig. 1.

A form with a rather narrow thallus and often with numerous proliferations along the margins was dredged by me in dirty water at a depth of about 20 feet near Hare Island, Tuticorin. At Cape Comorin Prof. IYENGAR has gathered a single female plant.

Distr.: Warmer Atlantic coasts of Europe and America, Mediterranean Sea, Red Sea, Indian Ocean, etc.

V. Ceramiales.

Fam. 1. *Ceramiaceae.*

Subfam. 1. Ceramieae.

Centroceras Kütz.

1. **Centroceras clavulatum** (Ag.) Mont. Cfr. Boergesen in Kew Bull., 1934, p. 18.

Distr.: Most warm seas.

Subfam. 2. Spyridieae.

Spyridia Harv.

1. **Spyridia filamentosa** (Wulf.) Harv. Cfr. BOERGESEN in Kew Bull., 1931, p. 14.

India: Tuticorin ; Shingly Island, leg. M. O. P. I.

Distr.: Most warm seas.

Fam. 2. *Rhodomelaceae*

Subfam. 1. Laurencieae.

Laurencia Lamour.

1. **Laurencia papillosa** (Forssk.) Grev., Algæ Britannicæ, 1830, p. LII. *Fucus papillosus* Forssk., Flora Aegypt.—Arab., 1775, p. 190. BOERGESEN, A revision of Forsskaal's Algæ (Dansk Bot. Arkiv, vol. 8, 1932, p. 6).

India: Tuticorin, Hare Island, 28th February 1928, leg. M. O. P. I.; Krusadi Island, Pamban, May 1924, leg. M. O. P. I.

Distr.: Most warm seas.

2. **Laurencia parvula** nov. sp.

Frons cæspitosa, ca. 1,5 mm. alta, e ramis basalibus repentibus et ramis erectis aut suberectis composita. Rami basales substrato (*Lithothamnium* sp.) adfixi, subteretes, ca. 500μ lait. Rami erecti teretes aut subteretes, sparsi aut interdum oppositi, clavati, in parte basali ca. 225μ lati, superne ad 500μ lati, apice late rotundato, aut simplices aut irregulariter ramosi. Tetrasporangia et cystocarpia ignota, antheridia in superiore parte ramorum orta.

India: Krusadi Island, leg. M. O. P. I.

Among the branches of a *Lithothamnion* a small *Laurencia* (fig. 27) was found which I have not been able to refer to any

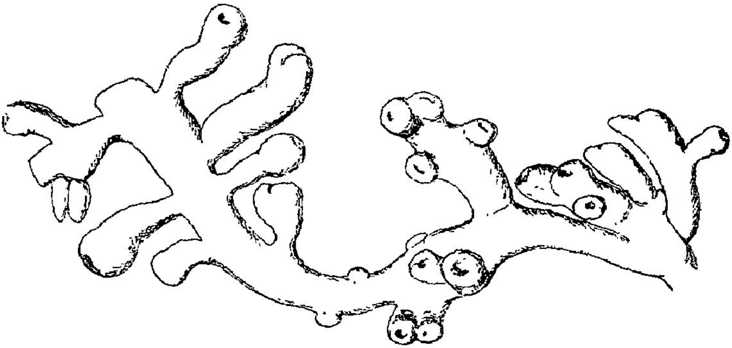


Fig. 27. *Laurencia parvula* nov. sp. Part of the thallus. × 10.

of the hitherto known small species. The decumbent creeping filaments are about 500μ broad; from these filaments erect or suberect short subclavate filaments are given out about 1,5 mm. high. Often they are simple but are sometimes more or less branched. At their base the branches are about 225μ thick, the upper broadly rounded summit about 500μ. The specimens were male plants. A transverse section shows that the epidermal cells are not protruding and that the cells are not palisade-like but are as long as broad. In the medullary tissue thickened walls are found here and there. When seen from above the epidermal cells in the main filaments are elongated and polygonal about 42μ long and 12μ broad with very thick walls; in the erect branches they are smaller.

This small *Laurencia* is perhaps most related to *L. pygmaea* Web. v. Bosse (in Mar. Alg. Sealark Exp. in Trans. Linn. Soc. Bot., vol. VIII, 1914, p. 122) but the thallus of the Indian plant is more robust and the tufts on the other hand shorter.

3. Laurencia flagellifera J. Ag., Spec. Alg., vol. 2, p. 747; Epicrisis, p. 648. Yamada, Notes on *Laurencia*, p. 197.

When I refer a specimen in Iyengar's collection to this species at first described on material from India, I must point out that I have not been able to compare it with the original material but it agrees very well with J. Agardh's description. The plant (fig. 28) forms dense tufts about 8-9 cm. high, the erect vertical terete densely placed filaments (about 1¼-1½ mm. thick) issuing from a large basal disc firmly fixed to the rock. Many of the filaments are quite unbranched, some become branched in

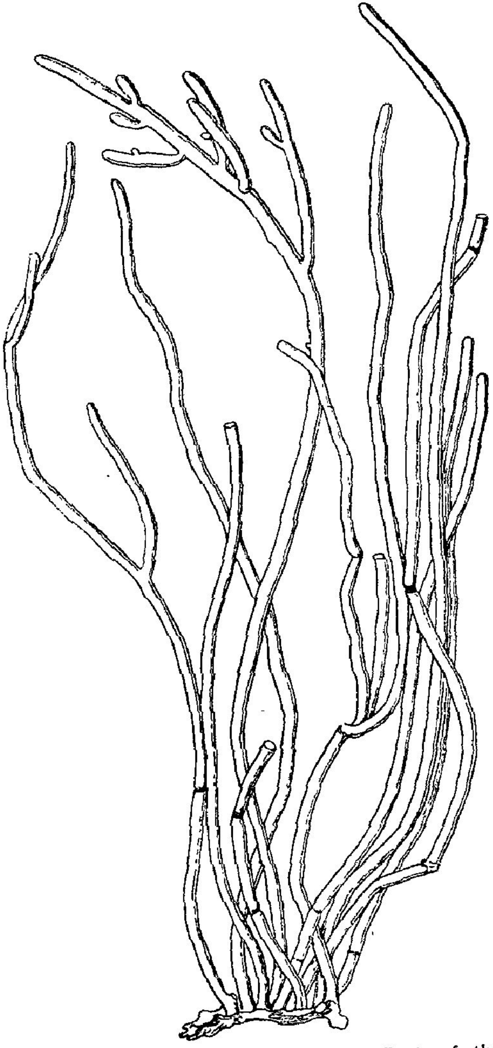


Fig. 28. *Laurencia flagelliformis* J. Ag. Part of the thallus. About × 2.

the upper parts. The branches are directed upwards and cylindrical with somewhat narrow bases; some of the lowermost branches are sometimes branched again. A transverse section shows that the surface cells are long, narrow and densely placed like palisades and not protruding as given in Yamada's description. On the other hand, now and then I found lenticular thickenings in the medullary tissue which YAMADA has not found.

The plant is most certainly perennial, dying down during the unfavourable season and leaving some stumps 2-3 cm. high from which the new shoots issue when the plant begins to grow again; dark annular scars are seen at the base most probably originating from the rejunenescence.

India: Cape Comorin, October 1926, leg. M. O. P. I.
Distr.: India.

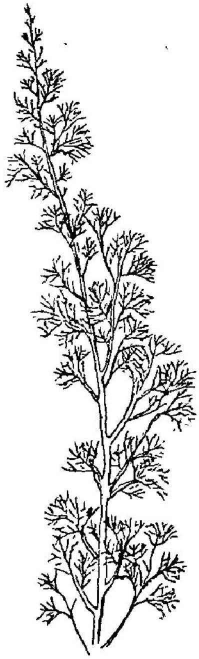


Fig. 29. *Polysiphonia unguiformis* nov. sp. Upper end of a main filament, × 6.

Subfam. 2. ***Chondrieae.***

Chondria (C. Ag.) Harv.

1. Chondria dasyphylla Ag. Sp. Alg., p. 350. Cfr. BOERGESEN in Kew Bull. 1932, p. 132 ; 1933, p. 133.

India: Tuticorin, Hare Island, leg M. O. P. I.

Distr.: Seems to occur in most warm seas.

Subfam. 3. ***Polysiphonieae.***

Poliysiphonia Grev.

1. Polysiphonia unguiformis nov. sp.

Thallus cæspitosus usque ad 4-6 cm. altus, ecorticatus, tetrasiphonius, articulatus. Pars basalis rhizoideis unicellularibus adfixa. Fila erecta principalia, inferne ca. 600μ lata, sursum gradatim attenuata, ramos ramelliferos gerentia. Rami in loco trichoblastorum oriuntur, quoqueversum egredientes, ca. 200μ lati; ramuli in parte basali ca. 100μ lati, superne acuti sunt.

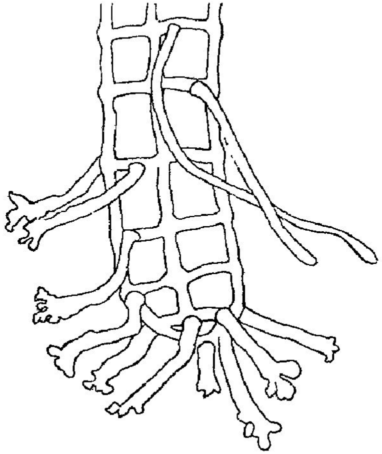


Fig. 30. *Polysiphonia unguiformis* nov. sp. Base of a plant × 110.

Tetrasporangia subglobosa ca. 70μ lata et longa, in ramulis orta, spiraliter seriata. Cystocarpia urceolata, ca. 300μ longa et 250μ lata ostiolo apicali non protracto munita. Antheridia sub-

cylindrica, 225μ longa et 25μ lata, superne sine cellula sterile, e ramulo basale trichoblastorum orta.

India: Shingly Island, October 1924, leg. M. O. P. I.

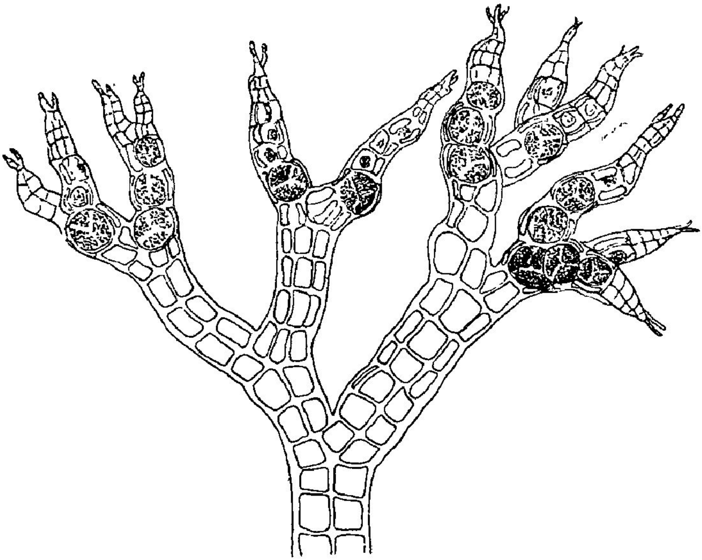


Fig. 31. *Polysiphonia unguiformis* nov. sp. Part of a tetrasporic plant. × 100.

The plant (fig. 29) forms tufts about 5-6 cm. high and was fixed by means of rhizoids to the leaves of a sea-grass, most probably *Enhalus acoroides*. The rhizoids are unicellular ending in irregularly shaped stellate discs (fig. 30). The main branches have percurrent axes and carry short scattered branch-systems, (fig. 29). These are several times pseudodichotomously divided. The uppermost ramuli taper very much upwards ending in acute apices. As the ramuli are often together in pairs with an angle of 30—40° between them, they remind one somewhat of the claws of a lobster (figs. 31, 32). The plant has 4 pericentral cells. No cortical layer is present. The trichoblasts are more or less developed in the upper ends of the filaments; they are placed in a screw turning left. Now and then a branch is produced instead of a

trichoblast. The main filaments near the base are about 600μ thick and the cells about 400μ long, but the length of the cells varies very much. The filaments are often narrowed in the parts between the cross-walls. In the short branch systems, the filaments become thinner to about 200μ. At their base the branches are about 100μ thick (fig. 31, 32). The tetrasporangia (fig. 31) are formed in the upper ends of the branchlets. They are placed in a short screw, and 3-4 are developed in each row, seldom more. They are almost globular and are about 70μ broad.

The cystocarps (fig. 32) are urceolate, about 300μ long and 250μ broad and at their upper ends only 150μ broad. In each of the branch-systems 2-4 cystocarps are generally formed.

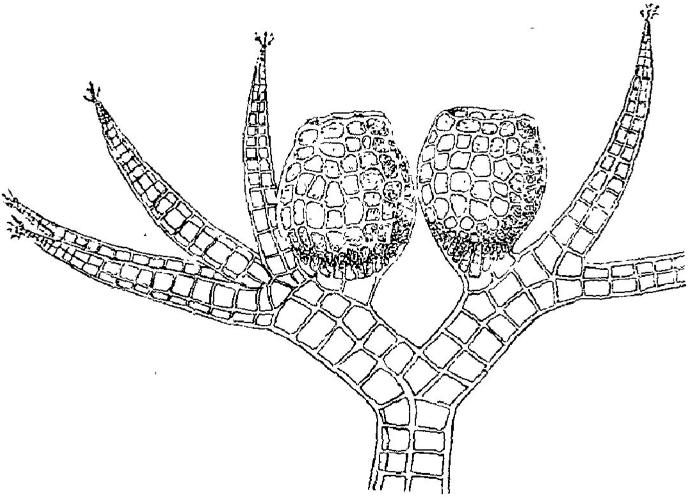


Fig. 32. *Polysiphonia unguiformis* nov. sp. Part of a female plant with cystocarps. × 120.

This species belongs to the group of *Polysiphonia* in which only a part of the trichoblast is transformed into the antheridial stand, namely, the first side branch of it (Compare: THURET ET BORNET, Etudes Phycologiques, Paris 1878, pp. 86, 87). Morover, no large sterile cells are found in the upper end of the androphores (fig. 33) which are elongated-ellipsoidal in shape and about 225μ long and 35μ broad, when fully developed.

Subfam. 4. **Polyzonieae.**

Leveillea Decsne.

1. **Leveillea jungermannioides** (*Mart.* et Her.) Harv. Cfr. BOERGESEN, Mar. Alg. Arabian Sea, p. 49.

India: Tuticorin, Hare Island!

Distr.: Red Sea, Indian Ocean, Australia.

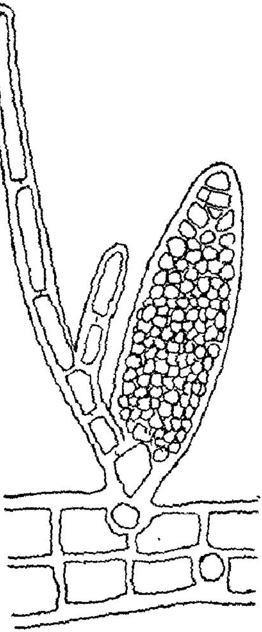
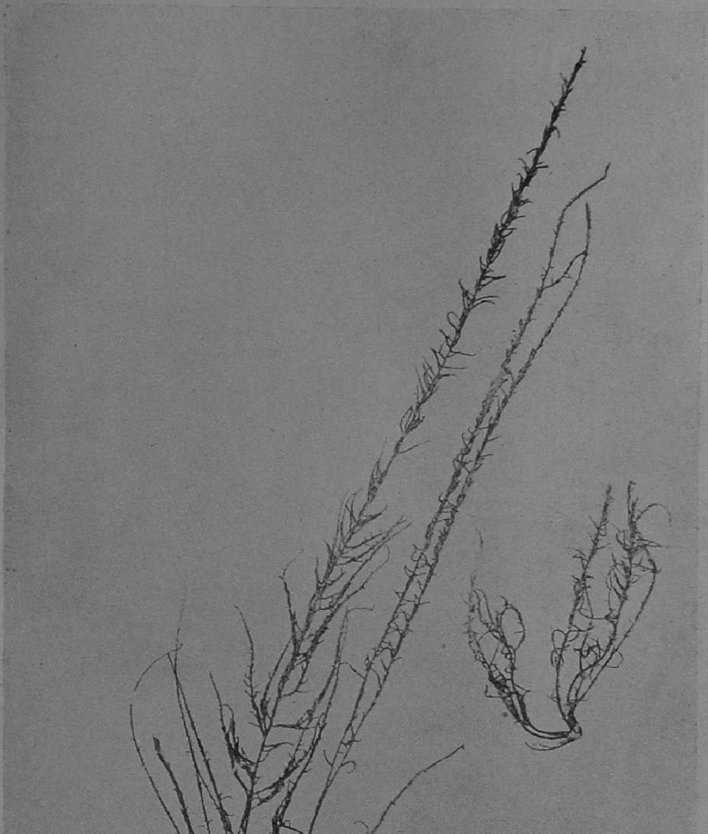


Fig. 33. *Polysiphonia unguiformis* nov. sp. An antheridial stand. × 500.

Explanation of Plate I

Liagora erecta Zeh A male plant to the left and a smaller female one to the right. The male plant is 40 cm. high.



F. BOERGESEN—*LIAGORA ERECTA* ZEH.